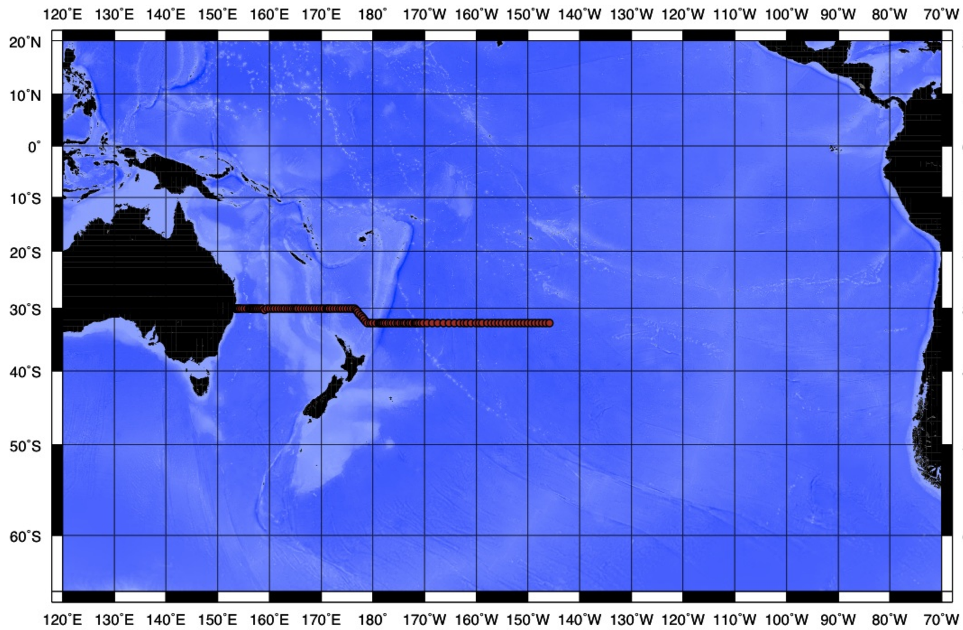
CRUISE REPORT: P06W

(Updated MAY 2010)



A. HIGHLIGHTS

A. 1. CRUISE SUMMARY INFORMATION

Section designation	**P06W**
Expedition designation (ExpoCodes)	**318M20091121**
Chief Scientist	**Alison M. Macdonald/WHOI**
Co-chief Scientist	**Shenfu Dong/UMiami/RSMAS**
Dates	21 NOV 2009 to 2 JAN 2010
Ship	*R/V Melville*
Ports of call	Brisbane, Australia, to Papeete, French Polynesia
Geographic boundaries	30° 4.2' S 153° 28.8' E 145° 50.47' W 32° 30.12' S
Stations	127
Floats and drifters deployed	2 APEX and 6 Iridium Floats Deployed
Moorings deployed or recovered	0

Chief Scientists:

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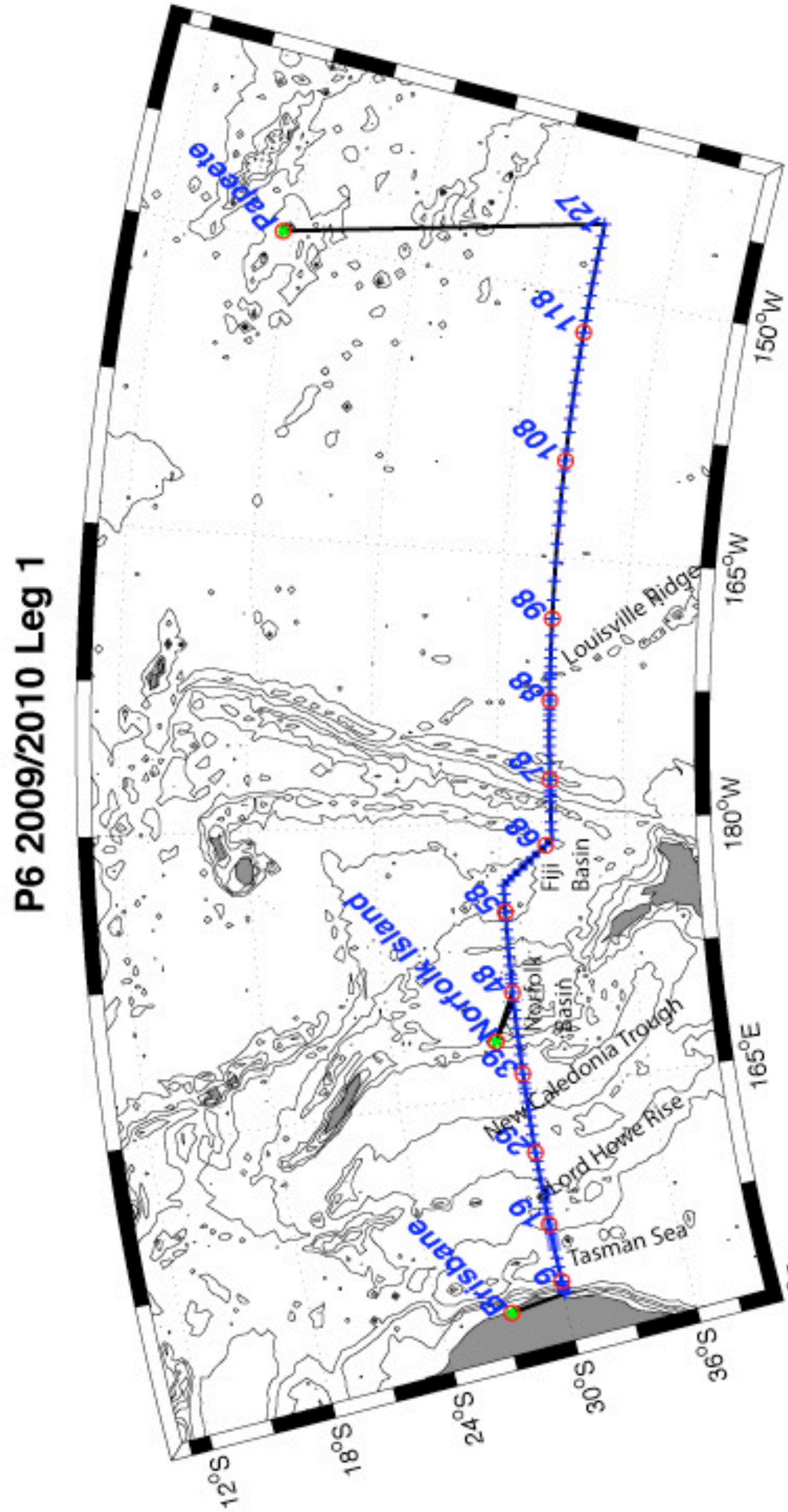
Cruise Summary Information	**Hydrographic Measurements**
Description of Scientific Program	**CTD Data:**
Geographic Boundaries	Acquisition
Cruise Track (Figure): PI CCHDO	Processing
Description of Stations	Calibration
Description of Parameters Sampled	Temperature Pressure
Bottle Depth Distributions (Figure)	Salinities Oxygens
Floats and Drifters Deployed	**Bottle Data**
Moorings Deployed or Recovered	Salinity
	Oxygen
Principal Investigators	Nutrients
Cruise Participants	Carbon System Parameters
	CFCs
Problems and Goals Not Achieved	Helium / Tritium
Other Incidents of Note	Radiocarbon

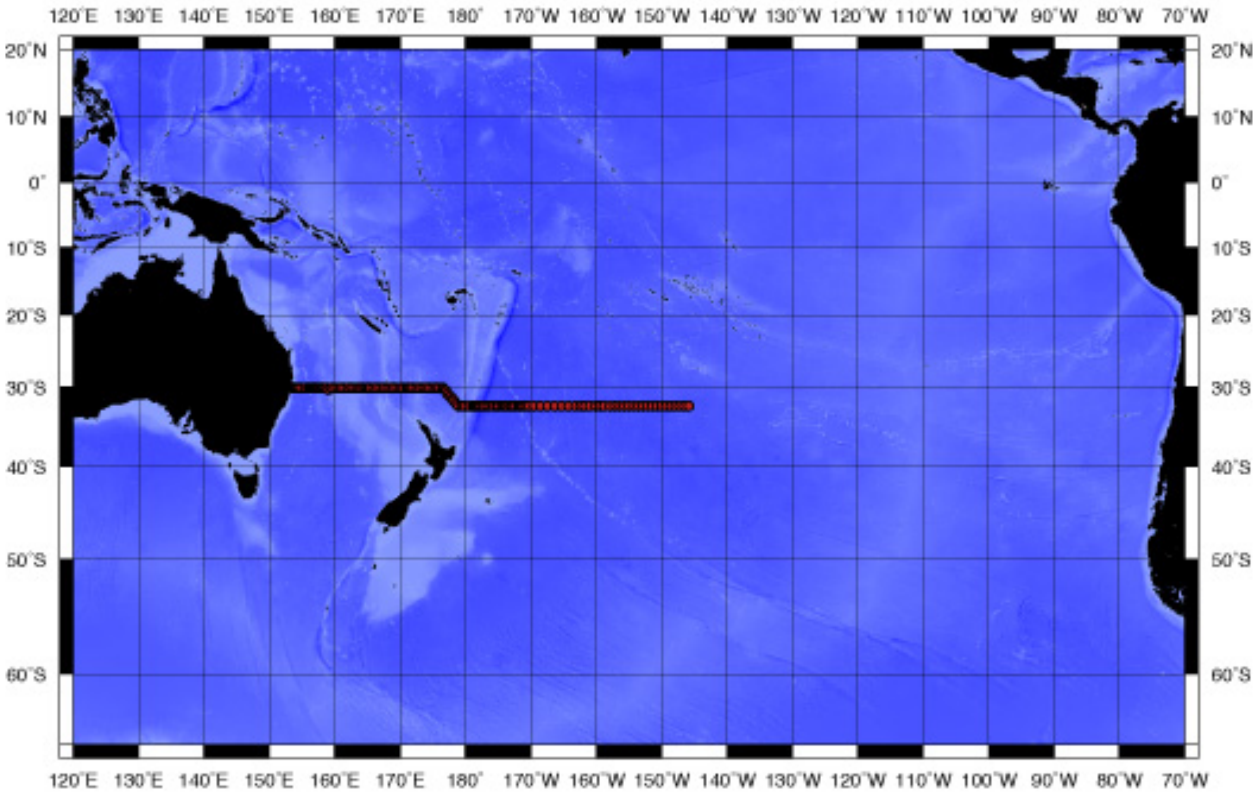
Underway Data Information	**References**
Navigation Bathymetry	Measurements/Calibrations
Acoustic Doppler Current Profiler (ADCP)	CO2
Thermosalinograph	pH
XBT and/or XCTD	Alkalinity
Meteorological Observations	
Atmospheric Chemistry Data	

Data Processing Notes	**Acknowledgments**



P6 2009/2010 Leg 1
papeete
Norfolk Island
Brisbane
Louisville Ridge
Fiji Basin
Norfolk Basin
New Caledonia Trough
Lord Howe Rise
Tasman Sea
127
118
108
98
88
78
68
58
48
39
29
19
9
12°S
18°S
24°S
30°S
36°S
150°E
165°E
180°W
165°W
150°W

Station Locations • P06 • 2009 • Macdonald/Dong • Melivlle



Acknowledgements

The U. S. Global Ocean Carbon and Repeat Hydrography Program (also known as the U. S. CLIVAR/ CO_2 Repeat Hydrography Program) has benefited from interagency, multi-institutional, and cross-disciplinary collaboration from its inception. Some of the ship time has been provided by NOAA on the NOAA Ship, Ronald H. Brown, and some by NSF on UNOLS ships, such as this cruise on R/V Melville. The traditional close cooperation between NSF and NOAA funded partners on this very long two-leg cruise was particularly strong. As usual on these cruises, NOAA analysts (1 from AOML and 1 from PMEL) measured dissolved inorganic carbon (DIC), while university teams measured pH and total alkalinity. While NSF funded SIO/ODF took the lead on CTD/O2, bottle salinity, bottle oxygen, and nutrients data collection and processing, NOAA personnel assisted in some of these areas, allowing for methodological cross training. Overall, the P6/leg 1 science party included representatives from 12 different institutions. It also included a strong international component with a nutrient analyst from CSIRO and 6 other non-US nations represented by science personnel working at US institutions. We are extremely grateful to NSF and NOAA, and our program managers, for the support, advice, and encouragement which continues to make this program a success.

Summary

A hydrographic survey consisting of Rosette/CTD/LADCP sections, trace metals rosette sections, underway shipboard ADCP and float deployments in the southern Pacific Ocean was carried out during late 2009. The R/V Melville departed Brisbane, Australia on 21 November 2009.

A total of 127 stations were occupied. 128 Rosette/CTD/LADCP casts and 60 Trace Metals rosette casts were made; 2 APEX Profilers and 6 Iridium floats were deployed from 22 November to 30 December 2009. Water samples (up to 36) and CTD data were collected on each Rosette/CTD/LADCP cast, usually made to within 15 meters of the bottom. Salinity, dissolved oxygen and nutrient samples were analyzed for up to 36 water samples from each cast of the principal Rosette/CTD/LADCP program.

Water samples were measured for DIC, pH, Total Alkalinity, and CFCs. Additional water samples DOC/TDN, Helium/Tritium, C13/C14, CDOM, Chlorophyll a, bacterial cell count, POC, Del 15N of NO3 and Cyanobacterial DNA enumeration were collected and stored for shore analysis. Underway surface pCO_2, temperature, conductivity, dissolved oxygen, fluorometer, meteorological and acoustical bathymetric measurements were made.

The cruise ended in Papeete, Tahiti on 2 January 2010.

A sea-going science team gathered from more than a dozen oceanographic institutions participated on the cruise. The programs and PIs, and the shipboard science team and their responsibilities, are listed below.

Principal Programs of CLIVAR P06

Program	Affiliation	PI	email
CTDO/Rosette, NUTs, O2, SAL, Data Processing	UCSD/SIO	James H. Swift	jswift@ucsd.edu
CO_2-Alkalinity, pH	UM/RSMAS	Frank Millero	fmillero@rsmas.miami.edu
CO_2-DIC/Underway pCO_2	NOAA/AOML	Rik Wanninkhof	Rik.Wanninkhof@noaa.gov
CFCs	UM/RSMAS	Rana Fine	rfine@rsmas.miami.edu
	UWashington	Mark War	nermwarner@ocean.washington.edu
Helium/Tritium	WHOI	William Jenkins	wjenkins@whoi.edu
DOC/TDN	UM/RSMAS	Craig Carlson	carlson@lifesci.ucsb.edu
13C/14C	WHOI	Ann McNichol	amcnichol@whoi.edu
	Princeton	Robert Key	key@Princeton.EDU
Trace Elements (Leg 1 only)	UHawaii	Chris Measures	chrism@soest.hawaii.edu
	FSU	Bill Landing	landing@ocean.fsu.edu
ADCP/LADCP	UHawaii	Eric Firing	efiring@soest.hawaii.edu
APEX and Iridium Floats	CSIRO	Anne Thresher	Ann.Thresher@csiro.au
Transmissometer	TAMU	Wilf Gardner	wgardner@tamu.edu
CDOM	UCSB	Norm Nelson	norm@icess.ucsb.edu
	UCSB	Craig Carlson	carlson@lifesci.ucsb.edu
Isotopic Composition of Nitrate	U. Mass.	Mark Altabet	maltabet@umassd.edu

Shipboard Scientific Personnel on CLIVAR P06

Name	Affiliation	Shipboard Duties	Shore Email
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Elizabeth Ann Burakowski	UNH	CTD Watch	elizabeth.burakowski@gmail.com
Valentina Gonzalez Caccia	UMiami/RSMAS	TAlk/pH	valecaccia@yahoo.com
John Calderwood	SIO/STS/RT	O2/Deck/ET	jcalderwood@ucsd.edu
Kenneth George Fairbarn, Jr.	UCSB	CDOM/Optics	kgdivekg@hotmail.com
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James David Happell	UMiami/RSMAS	CFC	jhappell@rsmas.miami.edu
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Robert Palomares	SIO/STS/RT	ET/Sal/Deck Leader	rpalomares@ucsd.edu
Jack Payette	FSU/UHawaii	Trace Metals	JackPayette@gmail.com
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Daniel Schuller	SIO/STS/ODF	Nutrients	dschuller@ucsd.edu
Karen Stamieszkin	Provincetown Cntr. for Coastal Studies	CTD Watch	kstamieszkin@coastalstudies.org
Andrew Stefanick	NOAA/AOML	Salts/Deck	Andrew.Stefanick@noaa.gov
Chantal Swan	UCSB	CDOM/Optics	swan@icess.ucsb.edu
Mimi Szeto	UNH	CTD Watch	szeto.mimi@gmail.com
Nancy Louise Williams	NOAA/PMEL	DIC	Nancy.Williams@noaa.gov
Ryan Jay Woosley	UMiami/RSMAS	TAlk/pH	rwoosley@rsmas.miami.edu
Franklin Delahoyde	SIO/STS/CR	Computer Technician	fdelahoyde@ucsd.edu
Keith Shadle	SIO/STS/RT	Resident Technician	restech@ucsd.edu

R/V Melville Officers and Crew

Name	Position
Chris Curl	Captain
Davis Seltzer	Chief Engineer
Eric Wakeman	1st Mate
Bryon Wilson	2nd Mate
Michelle Jackson	3rd Mate
Liz Mack 1st	A/E
Andrew Carter	2nd A/E
Philip Brennan	3rd A/E
Dave Grimes	Boatswain
John Juhasz	Electrician
Ed Keenan	A/B
Edmund Warren	A/B
Gordon Johnson	A/B
Bob Seeley	Senior Cook
Richard Buck	Cook
Jeanne Fleming	OS
Joe Sill	Oiler
Matt Slater	Oiler
Will Brown	Oiler
Bob Juhasz	Oiler
Peter Rogers	Wiper

Narrative

Introduction:

The R/V Melville (MV0911) "P06" cruise for the NSF and NOAA funded US CLIVAR/CO_2 Repeat Hydrography program carried out as a two leg transect of boundary-to-boundary full depth CTDO/ LADCP/ hydrographic/ carbon/ tracer stations along ca. 32.5°S. This first leg was occupied between November 21st 2009 and Jan 2nd 2010 from Brisbane, Australia to Papeete, French Polynesia. The full transect had been carried out twice before. In 1992 on the R/V Knorr (in three legs: Valparaiso, Chile to Easter Island 2 May – 26 May, 25 days, 66 stations, Easter Island to Aukland, NZ 30 May – 7 July, 37 days, 111 stations, Aukland NZ to Sydney, Australia 13 July to 30 July, 18 days, 78 stations including a number of repeats across the East Australia Current) and 2003 on the R/V Mirai (Brisbane, Australia to Papeete, French Polynesia, 3 August to 5 September, 34 days, 121 stations, Papeete to Valparaiso, Chile, 9 September – 16 October, 38 days, 116 stations) as part of the Blue Earth Global Expedition. Although well measured near the coasts and over steep topography, both these earlier occupations included large interior portions where station spacing exceeded 70nm. Thus, we planned a two long legs (44 and 38 days sea days respectively) to bring the station spacing to no more than 30 nm anywhere along the transect. On this first leg we have only been partially successful in this effort.

The Trials and Tribulations of the First Days:

The R/V Melville arrived more than a week ahead of the departure date as it had been undergoing maintenance in Keelung, Taiwan following the loss of its port thruster due to cracks in the shaft. All 33 members of the science team, as well as all equipment, did make it to Brisbane in time to leave port at 10:00 Nov. 21 (local time), but that is an understatement of the effort that went into making it happen. The chief scientist arrived a day earlier than most of the science party to get the lay of the ship, and with the help of both the SIO research technicians was able to begin to sort out the space and resources available to the 11 science groups who began to arrive on the 17th. Two vans (ODF storage van and the trace metal van) had previously been offloaded from the R/V Roger Revelle in Taiwan. SIO's van 8 to be used for helium/tritium (HT) analysis was also loaded in Keelung. Two more vans (WHOI's HT storage van and AOML's DIC analysis van) were loaded in Brisbane. Although it was the first to be sent, the DIC van did not arrive until the 19th because it was held up in customs. When it did arrive, the door hinges had to be removed to gain entrance, and so began the first of many trips to Bunnie's Warehouse (the local version of Home Depot).

A number of fairly major issues had to be overcome, not the least of which was determining how to fit everyone into the available space in a manner conducive to productive work. We were able to accomplish this task only because everyone was extremely accommodating of the needs of other's, compromising and rearranging where necessary. We fit the CTD watch, the LADCP setup and RNA/DNA analysis stations, TALK and pH, CFC, CDOM, DOC, and TM groups in the main lab along with space for individual computers and a workspace for the STS/ODF POC. The Science hold was full to capacity and we stored a number of containers of sampling bottles in the O1 computer lab (these were moved to the HT van as they were filled), some empty containers in the motor room, and many spare parts in waterproof boxes on the main deck. Our restech, Keith Shadle and STS POC, Rob Palomares did an amazing job producing space where none appeared to be.

Other issues included the late arrival of the Helium/Tritium storage van that was held up waiting for the DIC van to get through customs. The major difficulty was that the person doing the setup for HT was not joining the cruise, and it required two sleepless nights to organize the equipment and provide further training to the HT tech. It was also found that the noise from the air-conditioning unit in HT analysis van (van 8) made it nearly impossible to work. This noise was reduced somewhat in port through the efforts of the ship's electrician and local air-conditioner expert. Further work was done to reduce this noise while at sea. Nevertheless, van 8 retained a jet engine like ambiance for the first couple of weeks of the cruise (the unit died all together after being hit by wave during the storm which took place between stations 96 and 97).

Another difficulty was the near impossible task of getting the CFC gas tanks through customs, or rather into customs through the FedEx shipper. After numerous phone calls from the CFC onboard group, AOML in Miami, the Captain and the shipping agent, these tanks were finally placed on a truck in Sydney and arrived the afternoon of the 20th as did the acids for the TALK/pH group and the liquid nitrogen for the CDOM group. The willingness of the ship's captain to help with all these situations was greatly appreciated.

This cruise has dealt with a variety of issues with equipment. ODF got off to a rocky start as 4 of their computers were dead on arrival – mostly likely due to lack of moisture control. The systems had been repacked since leaving SIO. The computer tech and programmers worked long hours dealing this and the ensuing issues, and were able to get things to mostly come together prior to leaving port. However, as the computer tech had to focus his attention was elsewhere, there was some frustration on the part of the science groups, who had to wait longer than expected to get Internet access and ship email accounts. The CFC group has also dealt with a variety of problems, including initial failure of their equipment (over come using spare parts) and gas tanks contaminated with SF6 – making measurement of the tracer difficult, if not impossible. After leaving port, equipment failure allowed only one pH sample to be analyzed at a time (as opposed to the six expected). This, along with the fact the DIC group measured in a pattern of full cast, half cast, full cast, surface, led the ph/Talk group to measure a half cast every other station. Not long after leaving port the underway pCO_2 system failed completely and could not be repaired.

Our final small drama prior to sailing occurred when by 18:00 on the 20th, two of the student watch standers had not shown up. Phone calls to various local hotels and to the shipping agent, got us nowhere, but eventually, they appeared, completely oblivious to the panic they had caused. Unfortunately, one of them arrived with a fever and flu-like symptoms. The Captain and the chief scientist decided to allow her aboard, as long as, she was willing to stay quarantined in her berth, take Tamiflu and wear a mask once she was out. The fear here was bringing H1N1 on board. She did recover and no one else experienced any similar symptoms. Although much of the early part of this report deals with problems, our stay in port was not all bad. The highlights in Brisbane included; the conga–line of scientists and crew bringing food stores on board; one of our own playing saxophone with various local jazz groups, riding up and down the Brisbane river on the Cat Ferry, enjoying breezy warm evenings at outdoor cafes along the river, or some the many indoor and outdoor pubs, and one particularly wonderful Turkish restaurant, after spending days loading the ship in 95+°F conditions, and the port security guard who enjoyed greeting us after our evenings out with such news as 'the Melville has already left.'

Floats:

Eight floats were deployed. Although this is fewer than have been deployed on previous occupations, we were lucky to get them as over recent months the ARGO program has been dealing with serious issues with the pressure sensors used on the CTDs that led to uncomfortably high rates of premature failures. Dr. Ann Thresher at CSIRO was able to obtain new sensors from Seabird and so was able to supply us with the floats we deployed. Two of these were APEX floats, the other six were iridium floats (Table 2).

In general, the APEX float deployments were easy and uneventful, while the Iridium deployments were somewhat more difficult. Most of the difficulty arose because the noises/signals made by the floats and the detector were extremely quiet compared to the general background noise on the ship; because of the number of variety of signals that were to be listened for; and because of the time it took for the final signals to occur. We found it best to start the iridium floats up when the CTD/Rosette was either at or near the bottom, to allow a good two hours for the Iridium float signals to be detected. We started them up on the starboard deck away from winch and van air conditioner noise, and then carried them to the stern for deployment. The general consensus among those who had deployed ARGO floats was that the harness and box made deployment more difficult than necessary.

Hull No.	**Planned**		**Actual**		**Date (Utc)**	**Time (Utc)**	**Approx. Depth**	**Assoc. Ctdsta**
	LAT.	LON.	LAT.	LON.				
4683i	32°S	174.5°E	30.08°S	174.5°W	12/07/09	02:30	3624	
4684i	32°S	176.5°E	30.08°S	176.5°W	12/08/09	06:45	4279	
4685i	32°S	178.0°E	31.54°S	177.96°W	12/09/09	15:13	3846	
4681A	32°S	162.0°W	32.5°S	161.84°W	12/22/09	12:52	5424	
4686i	32°S	156.0°W	32.5°S	154.96°W	12/25/09	20:45	5040	
4687i	32°S	153.0°W	32.5°S	152.8°W	12/27/09	21:40	5040	
4682A	32°S	150.0°W	32.5°S	150.0°W	12/28/09	06:40	5140	
4688i	32°S	147.0°W	32.5°S	147.23W	12/29/09		4805	

Comments:

- 4783i Took well over an hour to get a constant signal from the detector
- 4686i Took three tries to get a satellite signal – could have been the detector
- 4687i Issue with detector was resolved by rotating the float within the box to bring the distance between the antenna and the detector to a minimum.
- 4688i Release mechanism took longer than usual to let go. The float was hauled almost all the way back in before it released.

The Casts:

Although not all the original 134 station positions were sampled. We were able to occupy 127 stations or 95% of what we originally intended. Of the 28 station pairs that had station spacing greater then 30 nm, 8 had spacing between 50 and 54 nm, and the rest averaged 36.2 ± 1.3 nm. None had the 70 nm spacing used in 1992 and 2003 occupations.

As stated in previously, we performed 127 CTD/Rosette casts. In choosing the bottle depths for each cast a rotating system of three schemes were used to allow for even sampling over all depth ranges. Similar schema were used and reported on I5, and earlier cruises have also used such staggering.

The schemes work under the assumption that bottom depth changes are fairly random in nature. They do not work well for the abyss when bottom depths change by less than difference between columns (see Tables E2-E4 and the explanation for use of the schemes given in the caption of Table E2) For the 6000 m trench casts, bottle depths were chosen to match the schemes at about 2000 m, while deep and abyssal bottles were individually chosen so that all depth ranges were sampled. Once again, care had to be taken in the abyss over the relatively flat plains beyond the trench in order that the first 300-500 meters above the bottom were sampled (see the 'hole' in sampling near the bottom of Fiji Basin (Figure E7). Use of the schemes was fairly, but not completely, successful as patches of relatively under-sampled water remained.

Lowered Acoustic Doppler Current Profiler Report CLIVAR P6 2009 Leg 1 Brisbane to Papeete

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Honolulu, HI 96822 <efiring@hawaii.edu>

An RD Instruments Work Horse 300kHz (WH300), Model WHM300IUG50, LADCP was used throughout the cruise, powered by a DEEPSEA Power & Light 50V SeaBattery. Both were installed on the main rosette by the resident technicians. The instrument worked well, providing full water column profiles of horizontal velocity currents with a vertical resolution of approximately eight meters.

LADCP downloading and processing were done using a netbook computer running Ubuntu Linux, and using a graphical interface software from University of Hawaii. Data was processed using LDEO software maintained by Andreas Thurnherr, with vertical profiles as well as longitude section plots being produced for general use. CTD time series data, but not shipboard ADCP data, were used to constrain calculations.

Two problems were encountered during the course of the cruise. Occasionally, on 10 casts out of a total of 127 stations, the WH300 LADCP would create two data files during the deployment. Without a single continuous data file it is not possible to process the data at this point, so there were a small number of stations that do not have processed data because of this problem.

Secondly, past the Tonga Trench and well into waters of the deep central part of the basin characterized by very clean water with a low sound scattering signal, which began at station 98 and continuing to station 127, the ping signal was too weak in the lower section of the water column to give reliable data. Throughout the water column, but particularly below 3000m, the current values are suspect, as these profiles have very high error in the current estimations because of the low ping signals, and gave large shear inverse difference errors during processing.

At station 52 and 54 (Fig 1) we see very interesting large magnitude (up to 40 cm/s), vertically alternating zonal flow, with a vertical wavelength of about 250 m, which may be evidence of a propagating internal wave, perhaps generated by tidal forces focused by the raised topography.

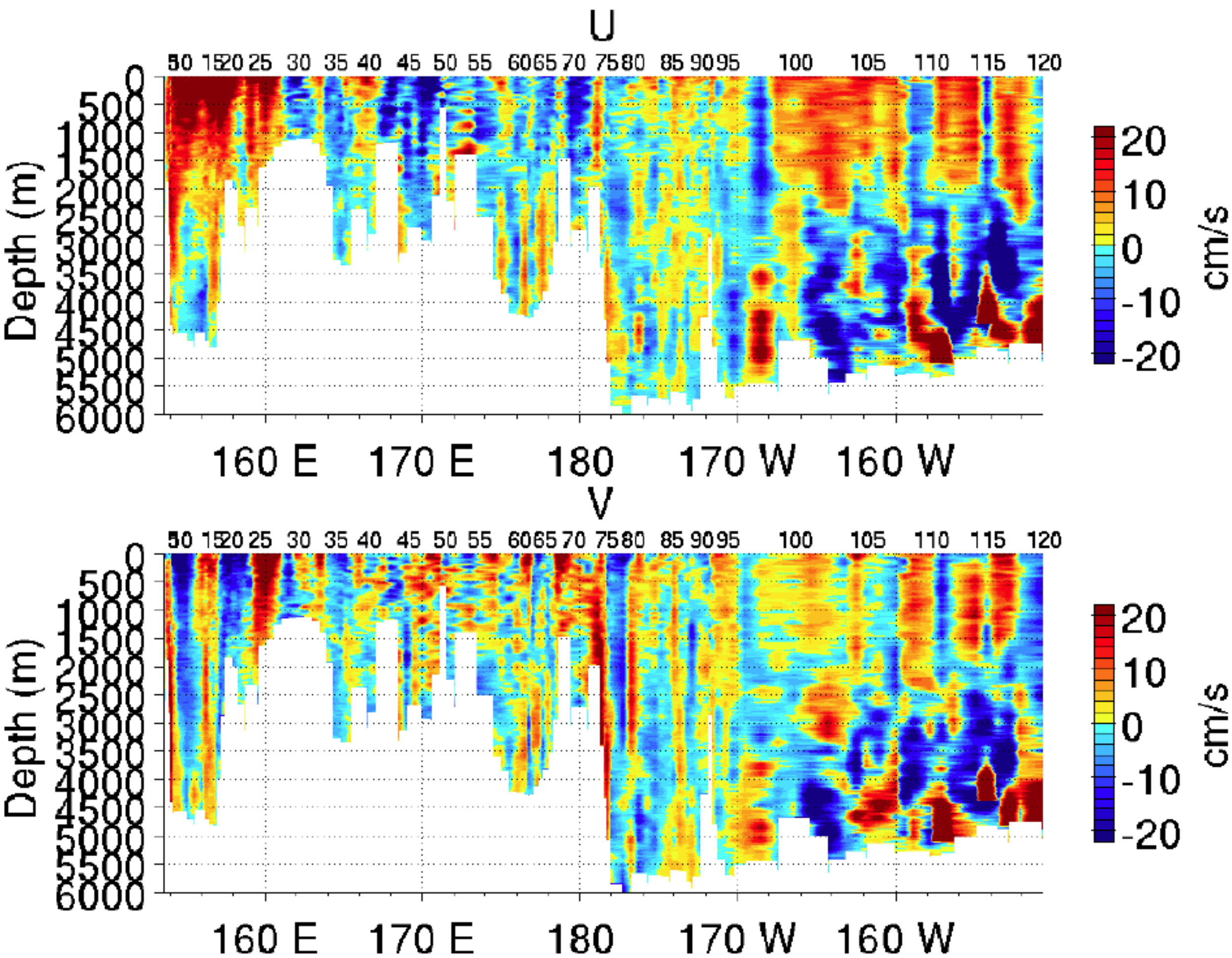

Fig 1: U (EastWest) & V (NorthSouth) P6 longitude depth current velocity section, Stations 2 to 120, (Note: velocity magnitudes often exceed color bar range at a number of locations)

Description of Measurement Techniques

1. CTD/Hydrographic Measurements Program

A total of 128 Rosette/CTD/LADCP casts were made at 127 stations. Most casts were lowered to within 5-15m of the bottom, occasionally further off because of ship roll, bottom topography or instrumentation depth limits.

Hydrographic measurements consisted of salinity, dissolved oxygen and nutrient water samples taken from each Rosette cast. Pressure, temperature, conductivity/salinity, dissolved oxygen, transmissometer and fluorometer data were recorded from CTD profiles. Current velocities were measured by the downward-facing LADCP. A few major problems occurred within the first 3 stations; then the rest of the cruise was fairly trouble-free.

The distribution of samples is shown in figure 1.0.

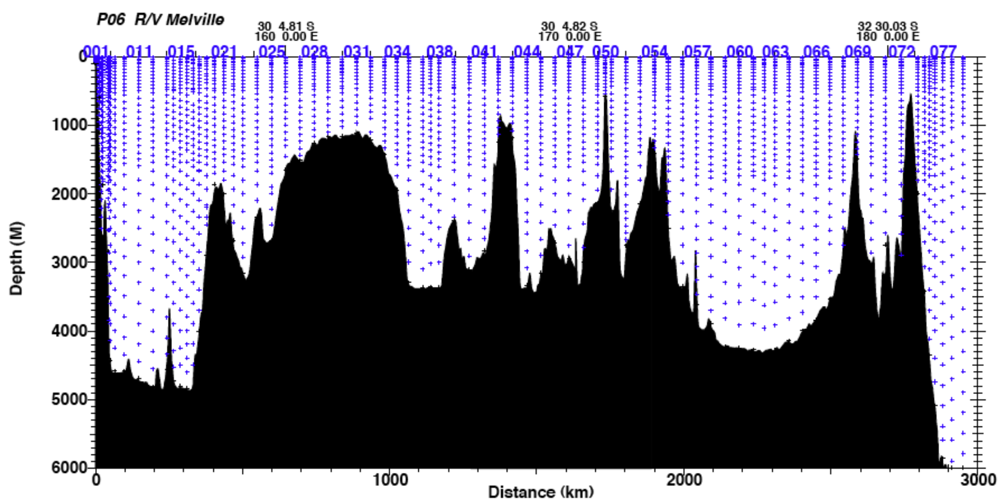

Figure 1.0: P06 Leg 1 Sample distribution, stations 1-79.

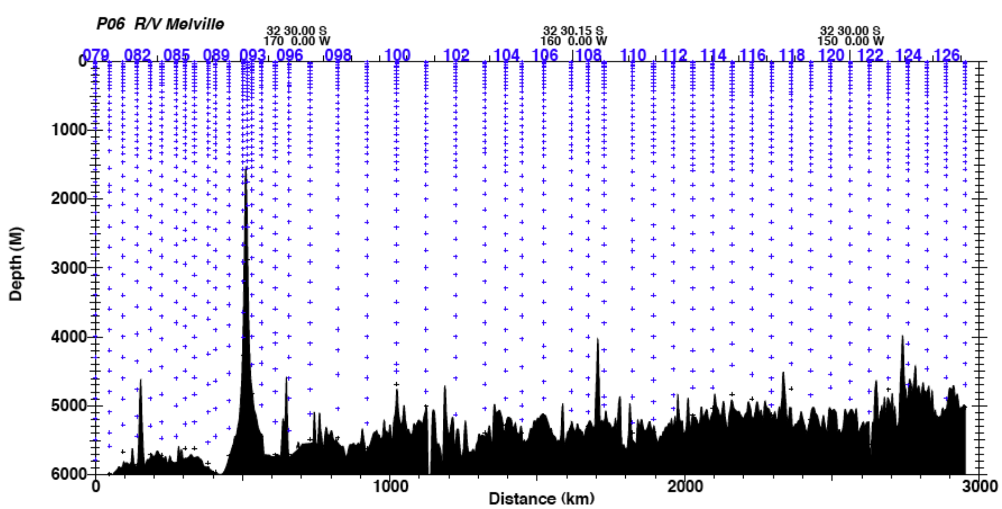

Figure 1.0: P06 Leg 1 Sample distribution, stations 79-127.

1.1. Water Sampling Package

Rosette/CTD/LADCP casts were performed with a package consisting of a 36-bottle rosette frame (SIO/STS), a 36-place carousel (SBE32) and 36 10.0L Bullister bottles (SIO/STS) with an absolute volume of 10.4L. Underwater electronic components consisted of a Sea-Bird Electronics SBE9plus CTD (SIO/STS #796) with dual pumps (SBE5), dual temperature (SBE3plus), dual conductivity (SBE4C), dissolved oxygen (SBE43), transmissometer (Wetlabs), fluorometer (Wetlabs CDOM), altimeter (Simrad) and LADCP (RDI).

The CTD was mounted vertically in an SBE CTD cage attached to the bottom of the rosette frame and located to one side of the carousel. The SBE4C conductivity, SBE3plus temperature and SBE43 Dissolved oxygen sensors and their respective pumps and tubing were mounted vertically in the CTD cage, as recommended by SBE. Pump exhausts were attached to the sensor bracket on the side

opposite from the sensors and directed downward. The transmissometer was mounted horizontally, and the fluorometer was mounted vertically along the bottom of the rosette frame. The altimeter was mounted on the inside of the bottom frame ring. The 150 KHz downward-looking Broadband LADCP (RDI) was mounted vertically on one side of the frame between the bottles and the CTD. Its battery pack was located on the opposite side of the frame, mounted on the bottom of the frame. Table 1.1.0 shows height of the sensors referenced to the bottom of the frame.

Table 1.1.0: Heights referenced to bottom of rosette frame

Instrument	Height in cm
Temperature sensors	11
SBE35	11
Altimeter	4
Transmissometer	8
CDOM Fluorometer	49
Pressure Sensor	28
Inner bottle midline	112
Outer bottle midline	119
BB LADCP XDCR Face midline	11
Zero tape	180

The rosette system was suspended from a UNOLS-standard three-conductor 0.322" electro-mechanical sea cable. The sea cable was terminated at the beginning of P06, and a retermination was performed prior to station 3 cast 5 due to a short in the signal wire. An additional mechanical retermination was performed prior to station 97 after a kink was found in the winch wire. The R/V Melville's DESH-6 winch was used for all casts.

The deck watch prepared the rosette 10-30 minutes prior to each cast. The bottles were cocked and all valves, vents and lanyards were checked for proper orientation. Once stopped on station, the rosette was moved out from the aft hanger to the deployment location under the A-frame using an air-powered cart and tracks. The CTD was powered-up and the data acquisition system started from the computer lab. The rosette was unstrapped from the air-powered cart. Tag lines were threaded through the rosette frame and syringes were removed from CTD intake ports. The winch operator was directed by the deck watch leader to raise the package. The A-frame and rosette were extended outboard and the package was quickly lowered into the water. Tag lines were removed and the package was lowered to 10 meters, until the console operator determined that the sensor pumps had turned on and the sensors were stable. The winch operator was then directed to bring the package back to the surface, re-zero the wipeout reading, and begin the descent.

Most rosette casts were lowered to within 5-15 meters of the bottom, using the altimeter, winch wireout, CTD depth and echosounder depth to determine the distance. One cast (station 3 cast 6) repeated only the top 600m to trip bottles missed on the previous aborted cast. Three casts (stations 78-80) were done at stations with bottom depths exceeding 6000m, the depth limit of some of the package instrumentation. These casts were lowered only to 6000m (~6120db).

For each up cast, the winch operator was directed to stop the winch between 6-36 standard sampling depths. These standard depths were staggered every station using 3 sampling schemes. To insure package shed wake had dissipated, the CTD console operator waited 30 seconds prior to tripping sample bottles. An additional 10 seconds elapsed before moving to the next consecutive trip depth, to allow the SBE35RTtime to take its readings. The deck watch leader directed the package to the surface for the last bottle trip.

Recovering the package at the end of the deployment was essentially the reverse of launching, with the additional use of poles and snap-hooks to attach tag lines. The rosette was secured on the cart and moved into the aft hanger for sampling. The bottles and rosette were examined before samples were taken, and anything unusual was noted on the sample log.
Each bottle on the rosette had a unique serial number, independent of the bottle position on the rosette. Sampling for specific programs was outlined on sample log sheets prior to cast recovery or at the time of collection.

Routine CTD maintenance included soaking the conductivity and oxygen sensors in fresh water between casts to maintain sensor stability, and occasionally putting dilute Triton-X solution through the conductivity sensors to eliminate any accumulating bio-films. Rosette maintenance was performed on a regular basis. Valves and o-rings were inspected for leaks.

1.2. Underwater Electronics

The SBE9plus CTD supplied a standard SBE-format data stream at a data rate of 24 frames/second. The sensors and instruments used during CLIVAR P06 Leg 1 are listed below.

Table1 2.0: CLIVAR P06 Rosette Underwater Electronics.

Instrument/Sensor	Mfr./Model	Serial Number	A/D Channel	Stations Used
Carousel Water Sampler	Sea-Bird SBE32 (36-Pl.)	3213290-0113	n/a	1-127
CTD	Sea-BirdSBE9plus	796	n/a	1-127
Pressure	Paroscientific Digiquartz	98627	n/a	1-127
Primary Temperature (T1)	Sea-Bird SBE3plus	03P-4907	n/a	1-127
Primary Conductivity (C1a)	Sea-Bird SBE4C	04-3369	n/a	1-102
Primary Conductivity (C1b)	Sea-Bird SBE4C	04-3430	n/a	103-127
Dissolved Oxygen Sea-Bird	SBE43	43-1508	Aux4/V6	1-127
Primary Pump	Sea-BirdSBE5T	05-4160	n/a	1-127
Secondary Temperature (T2)	Sea-Bird SBE3plus	03P-5046	n/a	1-127
Secondary Conductivity (C2)	Sea-Bird SBE4C	04-3578	n/a	1-127
Secondary Pump	Sea-Bird SBE5T	05-5124	n/a	1-127
Transmissometer	WETLabs C-STAR	CST-1115DR	Aux2/V2	1-67,73-127
Transmissometer	WETLabs C-STAR	CST-327DR	Aux1/V1	68-72
Fluorometer	WETLabsCDOM	flCDRTD-428	Aux1/V0	1-127
Altimeter	Simrad 807	9711091	Aux3/V4	1-127
Reference Temperature	Sea-Bird SBE35	35-0035	n/a	1-127
LADCP	RDIWHM300-I-UG50	13330	n/a	1-127
Deck Unit (in lab)	Sea-Bird SBE11	11P31807-0654	n/a	1-127

An SBE35RT reference temperature sensor was connected to the SBE32 carousel and recorded a temperature for each bottle closure. These temperatures were used as additional CTD calibration checks. The SBE9plus CTD was connected to the SBE32 36-place carousel providing for single-conductor sea cable operation. The sea cable armor was used for ground (return). Power to the SBE9plus CTD (and sensors), SBE32 carousel and Simrad 807 altimeter was provided through the sea cable from the SBE11plus deck unit in the main lab.

1.3. Navigation and Bathymetry Data Acquisition

Navigation data was acquired at 1-second intervals from the ship's GP90 GPS receiver by a Linux system beginning November 21. Bathymetric data were logged by the ship from the Knudsen 3.5 KHz echosounder or the SIS EM122 multibeam echosounder during Leg 1. The bottom depths reported in the data transmittal files were recorded on the Console Logs during acquisition, and later input manually into the postgreSQL database. Knudsen depths were typically reported, unless depth data were not available/reading 0.

1.4. CTD Data Acquisition and Rosette Operation

The CTD data acquisition system consisted of an SBE-11plus (V2) deck unit and three networked generic PC work stations running CentOS-5.4 Linux. Each PC work station was configured with a color graphics display, keyboard, trackball and DVD+RWdrive . One system had a Comtrol Rocketport PCI multiple port serial controller providing 8 additional RS-232 ports. The systems were interconnected through the ship's network. These systems were available for real-time operational and CTD data displays, and provided for CTD and hydrographic data management.

One of the work stations was designated the CTD console and was connected to the CTD deck unit via RS-232. The CTD console provided an interface and operational displays for controlling and monitoring a CTD deployment and closing bottles on the rosette. Another of the work stations was designated the website and database server and maintained the hydrographic database for P06. Redundant backups were managed automatically.

CTD deployments were initiated by the console watch after the ship had stopped on station. The acquisition program was started and the deck unit turned on at least 3 minutes prior to package deployment. The watch maintained a console operations log containing a description of each deployment, a record of every attempt to close a bottle and any relevant comments. The deployment and acquisition software presented a short dialog instructing the operator to turn on the deck unit, to examine the on-screen CTD data displays and to notify the deck watch that this was accomplished.

Once the deck watch had deployed the rosette, the winch operator lowered it to 10 meters. The CTD sensor pumps were configured with an 5-second startup delay after detecting seawater conductivities. The console operator checked the CTD data for proper sensor operation and waited for sensors to stabilize, then instructed the winch operator to bring the package to the surface and descend to a specified target depth (wire-out). The profiling rate was no more than 30m/min to 50m, no more than 45m/min to 200m and no more than 60m/min deeper than 200m, depending on sea cable tension and sea state.

The progress of the deployment and CTD data quality were monitored through interactive graphics and operational displays. Bottle trip locations were transcribed onto the console and sample logs. The sample log was used later as an inventory of samples drawn from the bottles. The altimeter channel, CTD depth, winch wire-out and bathymetric depth were all monitored to determine the distance of the package from the bottom, allowing a safe approach to 8-10 meters.

Bottles were closed on the up cast by operating an on-screen control. The winch operator was given a target wire-out for the bottle stop, proceeded to that depth and stopped. Bottles were tripped 30-40 seconds after stopping to allow the rosette wake to dissipate and the bottles to flush. The winch operator was instructed to proceed to the next bottle stop at least 10 seconds after closing bottles to ensure that stable CTD data were associated with the trip and to allow the SBE35RT temperature sensor to make a measurement.

After the last bottle was closed, the console operator directed the deck watch to bring the rosette on deck. Once the rosette was on deck, the console operator terminated the data acquisition, turned off the deck unit and assisted with rosette sampling.

1.5. CTD Data Processing

Shipboard CTD data processing was performed automatically during each Rosette/CTD/LADCP deployment, and at the end of each Trace Metals rosette deployment using SIO/ODF CTD processing software. The Trace Metals rosette contained its own CTD and carousel. These data were acquired using SBE SeaSave software, then copied to a Linux work station for further processing. No shipboard calibration was done for Trace Metals rosette CTD data.

Processing was performed during data acquisition for Rosette/CTD/LADCP deployments. The raw CTD data were converted to engineering units, filtered, response-corrected, calibrated and decimated to a more manageable 0.5-second time series. The laboratory calibrations for pressure, temperature and conductivity were applied at this time. The 0.5-second time series data were used for real-time graphics during deployments, and were the source for CTD pressure and temperature associated with each rosette bottle. Both the raw 24Hz data and the 0.5-second time series were stored for subsequent processing. During the deployment, the data were backed up to another Linux work station.

At the completion of a deployment a sequence of processing steps were performed automatically. The 0.5-second time series data were checked for consistency, clean sensor response and calibration shifts. A 2-decibar pressure series was then generated from the down cast. Both the 2-decibar pressure series and 0.5-second time series data were made available for downloading, plotting and reporting on the shipboard cruise website.

Rosette/CTD/LADCP data were routinely examined for sensor problems, calibration shifts and deployment or operational problems. The primary and secondary temperature sensors (SBE3plus)were compared to each other and to the SBE35 temperature sensor. CTD conductivity sensors (SBE4C) were compared to each other, then calibrated by examining differences between CTD and check sample conductivity values. The CTD dissolved oxygen sensor data were calibrated to check sample data. Additional Salinity and O2 comparisons were made with respect to isopycnal surfaces between down and up casts as well as with adjacent deployments. Vertical sections were made of the various proper ties derived from sensor data and checked for consistency.

A total of 128 casts were made using the 36-place CTD/LADCP rosette, and 60 casts using the 12-place Trace Metals rosette.

The primary temperature and conductivity sensors were used for reported CTD temperatures and conductivities for all but 3 stations. The secondary temperature and conductivity sensors were used as calibration checks, and for reported CTD data on stations 9, 10 and 102.

1.6. CTD Acquisition and Data Processing Problems

A few CTD acquisition and data processing problems were encountered on P06. During pre-cruise setup, two of four ODF computers would not boot, likely due to water exposure from inadequate packing and storage between I05 and P06. STS/CR reconfigured an idle computer within a day or so to run the ODF CTD data acquisition system. Various 32-bit/64-bit ODF software incompatibilities were encountered during testing in-port and underway to the test station, but all were resolved before the test cast.

The CTD signal died at about 45m on the test cast; the problem was traced to an internal failure in the altimeter, causing a power supply short and decreasing power to the CTD below operable levels. Altimeter 9711090 was replaced with 9711091 before the first P06 cast, and it worked well for the rest of the leg.

On station 2, winch stop comm problems caused the CTD to sit at 108db upcast for 15 minutes, with the winch meter inoperable. The Console Operator guided the winch from 90 mwo to the surface and bottle trip stops using the deck unit depth display in the main lab.

Station 3 was plagued with signal problems. On cast 2, the SBE5 pumps cut off at ~218db down-cast, and the cast was aborted; the pumps restarted at 120db up-cast. The wire was reterminated prior to cast 3, but the CTD signal cut out at 435m down, cast was aborted, and pumps came back on ~150m up-cast. Fluorometer/transmissometer were not connected to the CTD for cast 4; the signal was lost at 361m down, cast aborted, and signal back on at 230m up-cast. ET noted that signal failure was cyclic (every 5 seconds) and suspected pump circuit problems. The Y cable failed the megger test and was changed out prior to cast 5; the fluorometer and transmissometer were reconnected to the CTD. On cast 5, the CTD signal failed at 570m on the up-cast, after 10 bottles were tripped. The cast was brought back aboard, and the wire was reterminated. A last cast 6 at station 3 was done to collect the water at depths missed on the aborted cast 5; no problems noted.

Because of interdependencies between the ODF Linux systems, the start of station 4 was delayed 30 minutes when the database computer suddenly died and could not be resurrected. The last of the four ODF computers shifted over from the I05 cruise died within a few minutes of the database system. Critical data was shifted across from backups, while the database system's hard drive was installed in the acquisition computer so it could run stand-alone. 3 of 4 dead ODF computers were diagnosed as having corrupted memory, based on diagnostic beeps from their motherboards. While the CTD data processor slept, the two processing computers were magically revived by the STS/CR technician, presumably by using parts from the other two dead computers; both computers ran reliably for the rest of the leg.

The navigation feed to the ODF acquisition system was lost during the transit between stations 5/6. Changing the cable to a different serial port had no effect, and the serial cable/data feed tested out fine to a nearby laptop. The problem was resolved by changing out a faulty DB9/DB25 connector between the cable and serial ports. No further computer hardware issues were encountered.

Multiple problems were encountered throughout the leg with the LCI-90 display for the winch. The LCI-90 apparently overheated, causing it to blank out, typically while the winch was stopped for bottle trips. Most casts required multiple resets, which involved manually flipping the breaker to the winch (in the main lab) off and on. Occasionally the wireout reading shifted or rezeroed during these breaker trips, causing negative readings or offsets for a substantial part of the up-casts.

The winch was apparently running only 20m/min on many up-casts during the first half of the leg, but apparently it was not because of any LCI-90 or winch issue. More specific directions were given to console and winch operators on optimal winch speeds, provided winch tension and sea state cooperated; these were followed well for the remainder of the leg.

Station 7/2 had a noisy transmissometer signal in 200-550m range. The lens was not cleaned because a strap was in the way. On stations 9 and 10, either a transitory pump problem or an organic matter obstruction, not noted by the console operator, resulted in unusable primary data for the top 32 decibars. Secondary downcast data were used (vs. upcasts) to preserve T/S structure near the surface, despite the loss of useful CTD O2 data for the near-surface area. Both pump tubes were flushed with tap water prior to station 15, in case anything was still in the tubes.

Bow thruster problems caused difficulty keeping the ship on-station, so the ship was moved to a new position prior to station 14. On station 22, the package came out of the water at the top of the surface yoyo when the winch went the wrong direction; another yoyo was done to restabilize the sensors before starting down. At the end of the cast, the deck brought the rosette out before the last bottle was tripped; it was re-immersed and stabilized before the surface bottle was tripped.

There was a 22-hour delay between stations 47/48 for a medical evacuation of a crew member at Norfolk Island. Triton X solution was left in pump tubes during most of the run, to see if the C2 drift could be stabilized. The deck unit was left on between stations 59/60; the pumps were on the entire time, due to salty water in the pump tubes. The CTD signal was observed closely during station 60, and the pumps appeared to be working normally. The syringes were left off the CTD intake lines for over an hour after station 60, but were put back on at least 1.5 hours before cast.

On station 63, the bottom trip was forgotten when the console operator was asked a flurry of questions about CTD depth by the bridge. Since no bottles had been tripped, the package was sent back down from 4158db to do the trip. 1 to 4 transitory signal spikes, sometimes accompanied by audible short deck unit alarms, occurred during 9 casts, starting with station 63. Most of them occurred on up-casts while the winch was moving between bottles, one or two occurred on down-casts. They were very short-lived (about 0.25 seconds) and did not cause a problem with data.

The transmissometer was changed out before station 68 when the elusive Y cable required for connecting the TAMU transmissometer was found. The fluorometer was re-cabled to the other end of the Y on a different AUX port when the transmissometer was installed. The TAMU transmissometer signal drifted slowly downward from start to end of its first cast. The transmissometer signal offset/dropped in segments of several hundred meters or more during each subsequent cast (69-72), but otherwise tracked well between down and up. The transmissometer was changed back to the original before station 73, and the fluorometer was re-cabled independently and moved back to its original AUX port on the CTD. The fluorometer signal was absent during station 73, but was resurrected by flipping the connector cable ends before station 74.

The wire settled a bit after station 71 terminal depth was reached; the bottom wire-out was readjusted back up 3m before the bottom bottle was tripped. The target for 1850m was mis-calculated, and the winch was taken back down 20m to 1815m for the missed trip.

On station 95/2, the winch was stopped at 75m for "fuzzy" salinity and O2 signals. The cast was continued after the signal was deemed stable. Shortly thereafter, the CTD processor arrived on watch and determined the signal was not ok after all. As the cast was reversed at 924m to bring the package back out to check for obstructions, all primary signals took a large downward dive. A salp (jelly critter) had completely blocked the primary T/C duct and was sucked out intact with the flushing syringe and DI water by the ET. The CTD signals were fine on cast 3; but the winch could not reset at the surface, so winch readings were 29m low for the entire cast.

There were 3 spontaneous "mystery mis-trips" about 30-40 seconds apart on the up-cast of station 96 at bottles 28-30, not triggered by the console operator. Bottles 34-36 were tripped on-the-fly in the mixed layer due to weather conditions. There were 2 kinks in the winch wire after recovery, at3mand 5m from the termination. The wire tested fine electrically, so only the mechanical termination was redone. There was a 1-day weather delay prior to station 97.

The transmissometer signal was noisy from 2830db to the surface on the up-cast of station 101. During station 102, the primary conductivity offset +0.3 mS/cm during the down-cast, and an additional +0.03 mS/cm more on the up-cast. Secondary data were reported for that cast, and the primary conductivity sensor was replaced before station 103. There was transitory organic contamination in the primary pump tube at 1572-1578db on the down-cast of station 111, causing offsets in CTD salinity and oxygen signals. The data were despiked after cast.

On station 112, the winch stopped 12 minutes at 5300-5302db on the down-cast. The CTD O2 signal offset low during this stop, but the data drop was fixed with a small offset of raw data from the stop to the bottom of the cast at 5422db before fitting to bottle data. On station 127, the fluorometer signal read 4.9+V most of the cast, instead of more typical readings around 0.1+V. Apparently a bag of Styrofoam cups were placed on the rosette so they obstructed the fluorometer sensors. The fluorometer read 0.26V on deck and tested out fine.

1.7. CTD Sensor Laboratory Calibrations

Laboratory calibrations of the CTD pressure, temperature, conductivity and dissolved oxygen sensors were performed prior to CLIVAR P06. The calibration dates are listed in table 1.7.0.

Table 1.7.0: CLIVAR P06 CTD sensor laboratory calibrations.

Sensor	S/N	Calibration Date	Calibration Facility
Paroscientific Digiquartz Pressure	98627	10-July-2009	SIO/STS
Sea-Bird SBE3plus T1 Temperature	03P-4907	2 July 2009	SIO/STS
Sea-Bird SBE3plus T2 Temperature	03P-5046	6 July 2009	SIO/STS
Sea-Bird SBE4C C1a Conductivity	04-3369	16 June 2009	SBE
Sea-Bird SBE4C C1b Conductivity	04-3430	16 June 2009	SBE
Sea-Bird SBE4C C2 Conductivity	04-3578	16 June 2009	SBE
Sea-Bird SBE43 Dissolved Oxygen	43-1508	1 July 2009	SBE
Sea-Bird SBE35 Reference Temperature	35-0035	20 June 2009	SBE

ODF typically calibrates sensors about two months before a CLIVAR expedition. However, the 2-month cruise delay for 6 came after the sensors were shipped in anticipation of an early September start date.

1.8. CTD Shipboard Calibration Procedures

CTD #796 was used for all Rosette/CTD/LADCP casts during P06. The CTD was deployed with all sensors and pumps aligned vertically, as recommended by SBE. The primary temperature sensor (T1/03P-4907) and conductivity sensors (C1a/04-3369, stas 1-102 or C1b/04-3430, stas 103-127) were used for all reported CTD data for stations 1-127, with 3 exceptions. Secondary sensors (T2/03P-5046 & C2/04-3578) were reported for stations 9, 10 and 102.

The SBE35RTDigital Reversing Thermometer (S/N 3528706-0035) served as an independent calibration check for T1 and T2. In-situ salinity and dissolved O2 check samples collected during each cast were used to calibrate the conductivity and dissolved O2 sensors.

1.8.1. CTD Pressure

The Paroscientific Digiquartz pressure transducer (S/N 98627) was calibrated in July 2009 at the STS/ODF Calibration Facility. The calibration coefficients provided on the report were used to convert frequencies to pressure; then the calibration correction slope and offset were applied to the converted pressures during each cast. Pre- and post-cast on-deck/out-of-water pressure offsets varied from +0.5 to +0.7 db before and after the aborted test cast. An additional -0.5db correction was applied during data acquisition/block-averaging starting with station 1. Residual pressure offsets (the difference between the

1.8.2. CTD Temperature

The same primary (T1/03P-4907) and secondary(T2/03P-5046) temperature sensors were used during all Leg 1 casts. Calibration coefficients derived from the pre-cruise calibrations, plus shipboard temperature corrections determined during the cruise, were applied to raw primary and secondary sensor data during each cast.

A single SBE35RT was used as a tertiary temperature check. It was located equidistant between T1 and T2 with the sensing element aligned in a plane with the T1 and T2 sensing elements. The SBE35RT Digital Reversing Thermometer is an internally-recording temperature sensor that operates independently of the CTD. It is triggered by the SBE32 carousel in response to a bottle closure. According to the manufacturer's specifications, the typical stability is 0.001°C/y ear. The SBE35RT on P06 was set to internally average over an 8 second period.

Two independent metrics of calibration accuracy were examined. At each bottle closure, the primary and secondary temperature were compared with each other and with the SBE35RT temperatures.

Only small temperature corrections were required during P06 Leg 1. The primary temperature sensor exhibited a second-order pressure response, and the secondary sensor had a first-order pressure response when compared to the SBE35RT. Surface offsets for both sensors remained fairly stable until bottom depths starting closing in on 6000m. Starting at station 77, T1 shifted -0.3 m°C and required an additional offset. The slope for T2 appeared to change at the same time, and was adjusted from station 77 onward.

The final corrections for both temperature sensors used on P06 are summarized in Appendix A. All corrections made to CTD temperatures had the form:

$$T_{cor} = T + tp_2P^2 + tp_1P + t_0$$

Residual temperature differences after correction are shown in figures 1.8.2.0 through 1.8.2.5.

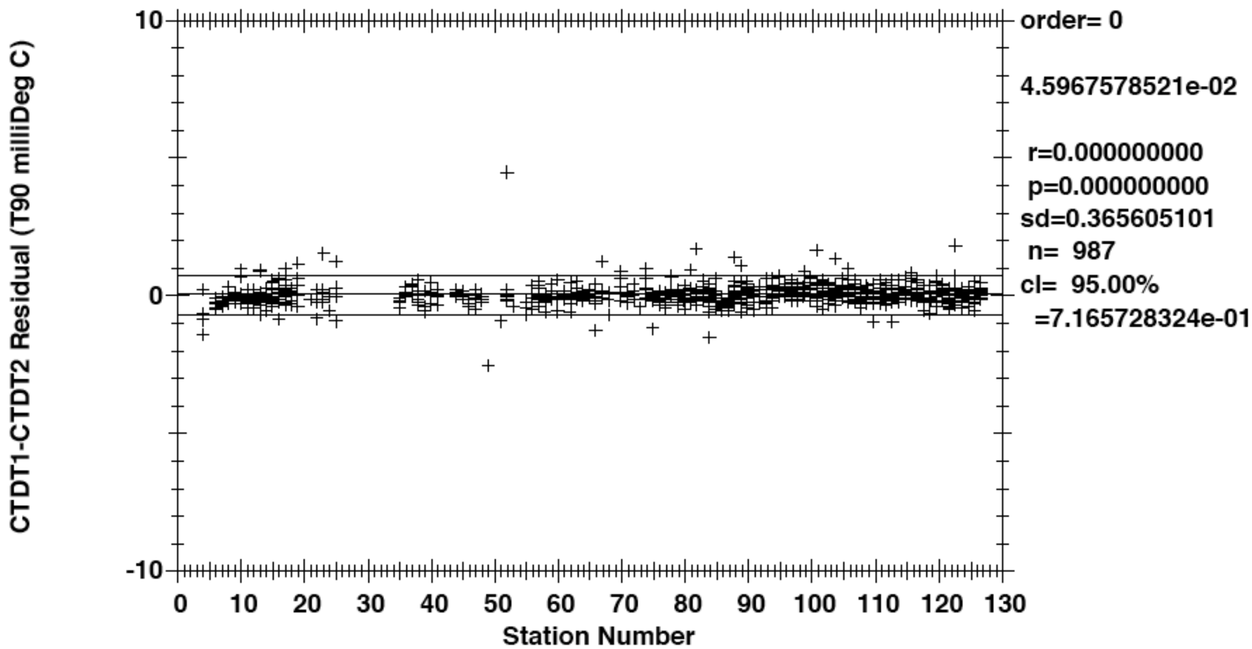

Figure 1.8.2.0: T1-T2 by station (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

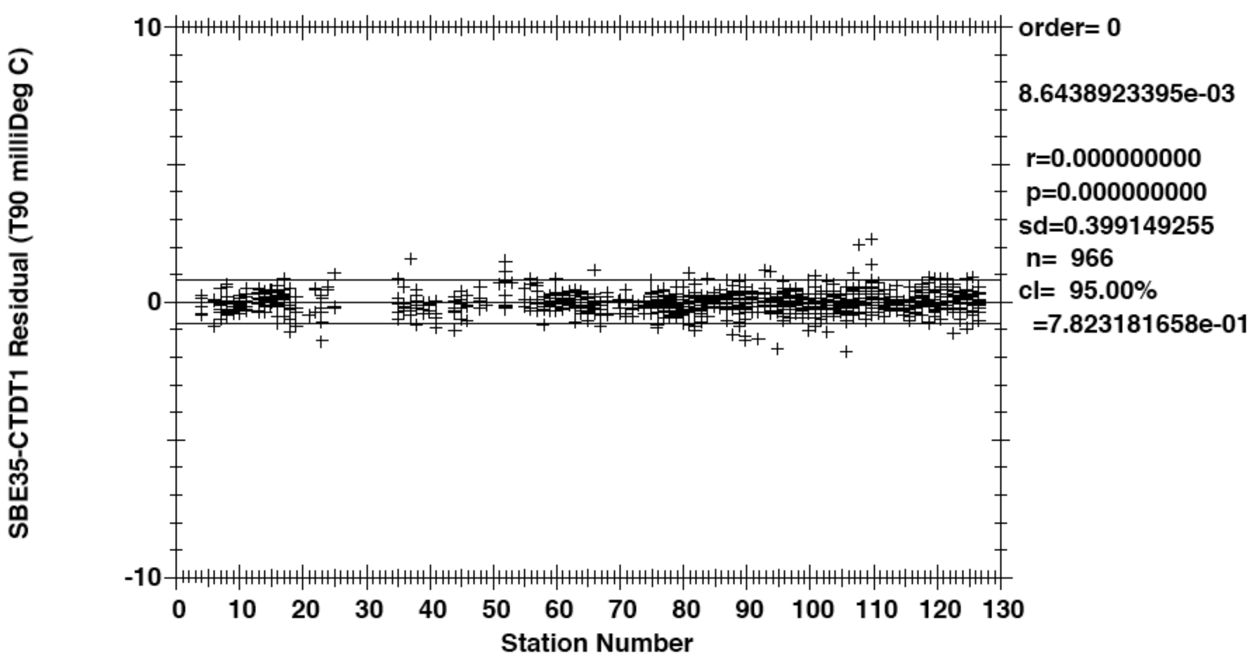

Figure 1.8.2.1: SBE35RT-T1 by station (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

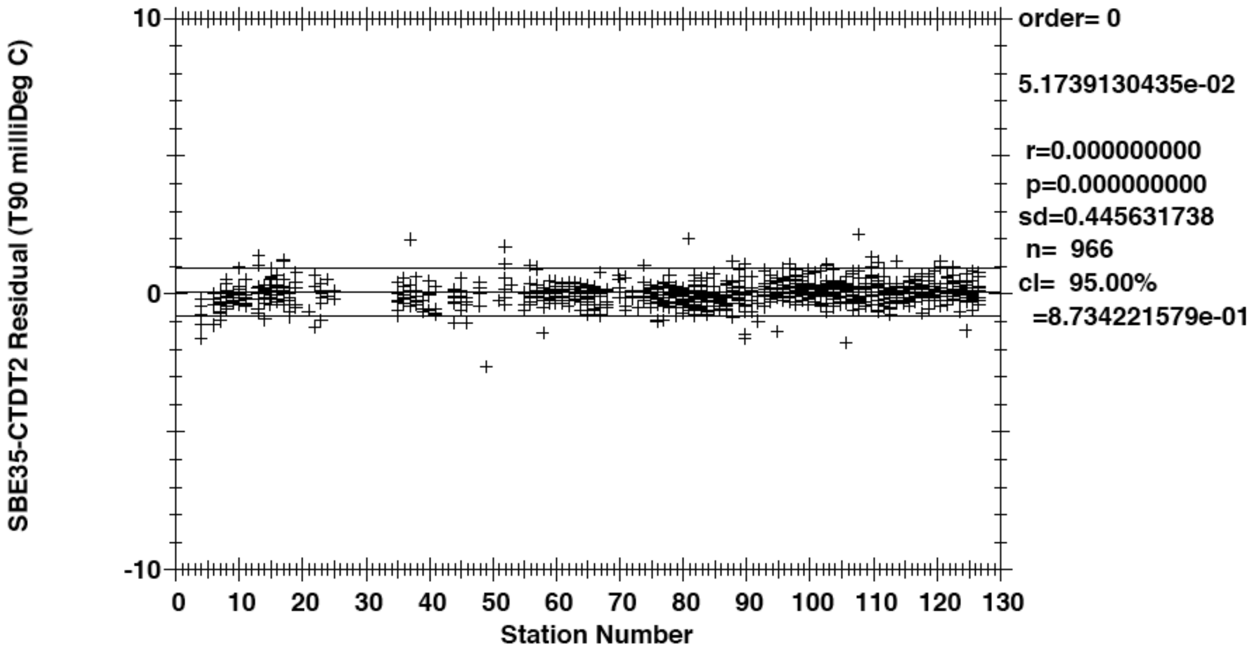

Figure 1.8.2.2: SBE35RT-T2 by station (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

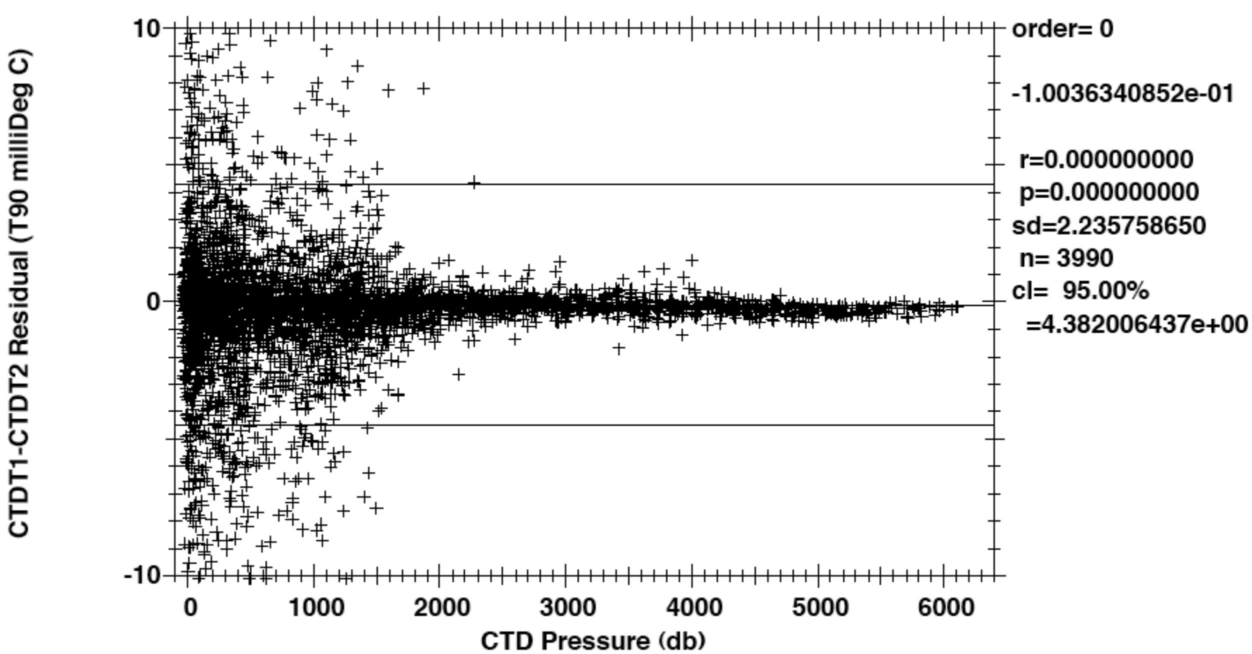

Figure 1.8.2.3: T1-T2 by pressure (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

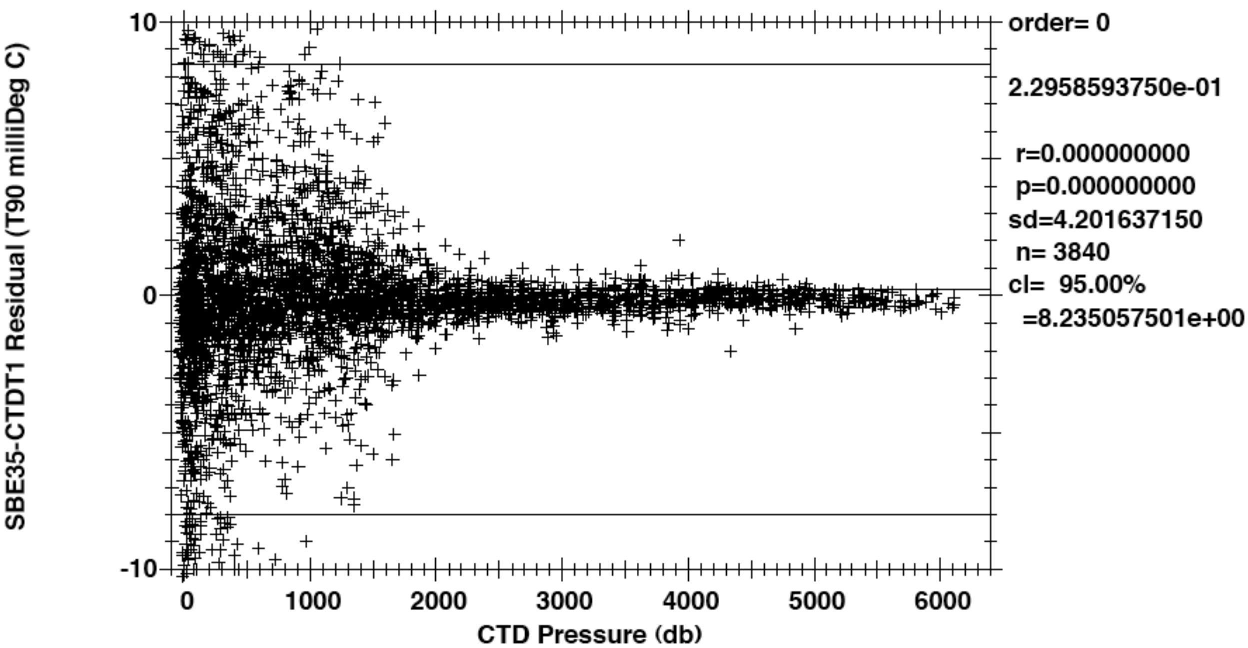

Figure 1.8.2.4: SBE35RT-T1 by pressure (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

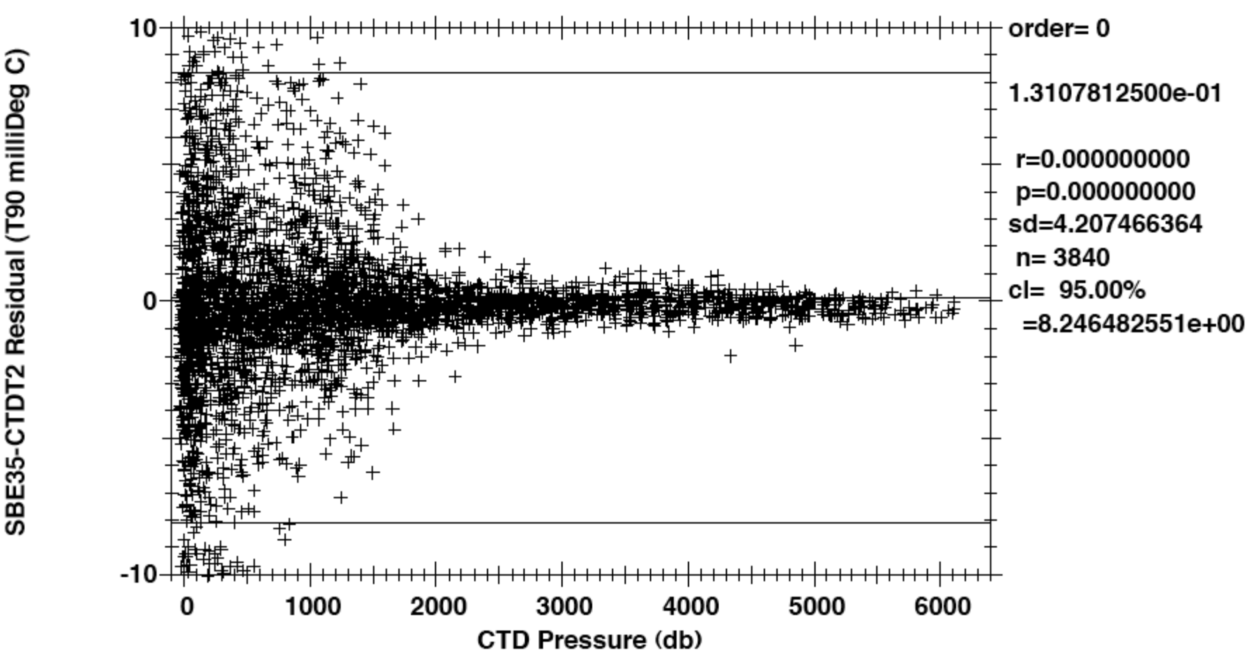

Figure 1.8.2.5: SBE35RT-T2 by pressure (-0.01°C ≤ T1 - T2 ≤ 0.01°C).

The 95% confidence limits for the mean low-gradient differences are ±0.00072°C for T1-T2, ±0.00078°C forSBE35RT-T1 and ±0.00087°C for SBE35R T-T2.

1.8.3. CTD Conductivity

Two primary conductivity sensors (C1a/04-3369, stas 1-102 and C1b/04-3430, stas 103-127) and a single secondary conductivity sensor (C2/04-3578) were used during Leg 1. Calibration coefficients derived from the pre-cruise calibrations were applied to convert raw frequencies to conductivity. Shipboard conductivity corrections, determined during the cruise, were applied to primary and secondary conductivity data for each cast.

Corrections for both CTD temperature sensors were finalized before analyzing conductivity differences. Two independent metrics of calibration accuracy were examined. At each bottle closure, the primary and secondary conductivity were compared with each other. Each sensor was also compared to conductivity calculated from check sample salinities using CTD pressure and temperature.

The differences between primary and secondary temperature sensors were used as filtering criteria to reduce the contamination of conductivity comparisons by package wake. The coherence of this relationship is shown in figure 1.8.3.0.

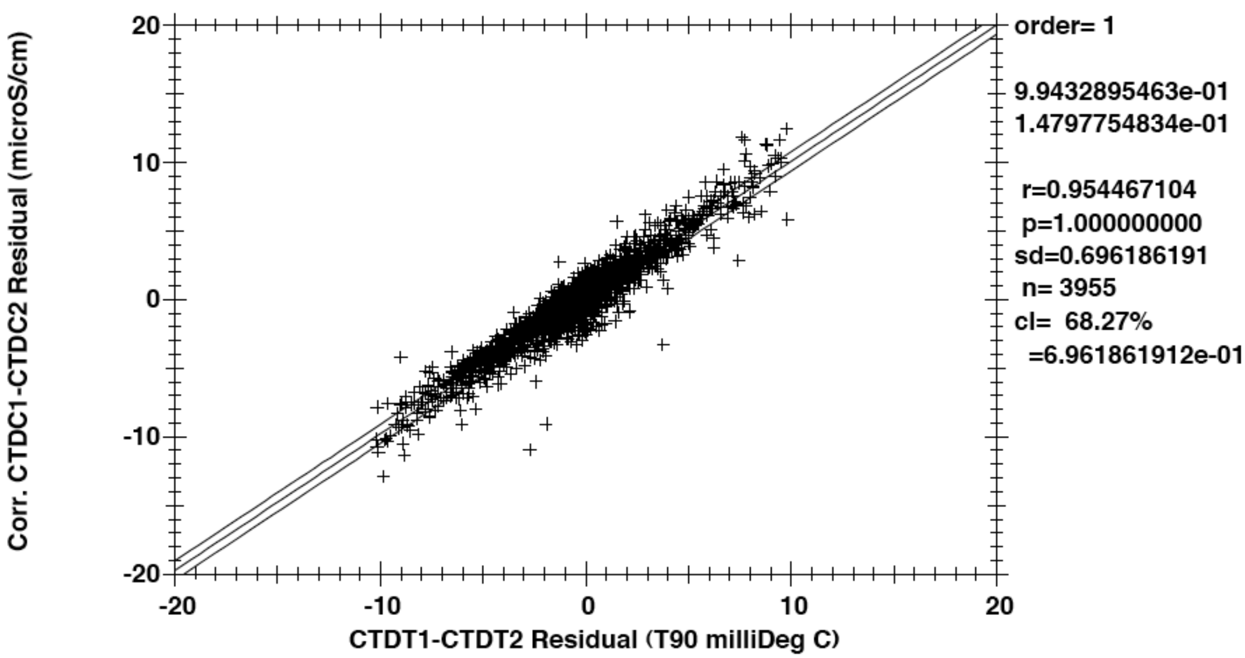

Figure 1.8.3.0: Coherence of conductivity differences as a function of temperature differences.

Uncorrected conductivity comparisons are shown in figures 1.8.3.1 through 1.8.3.3.

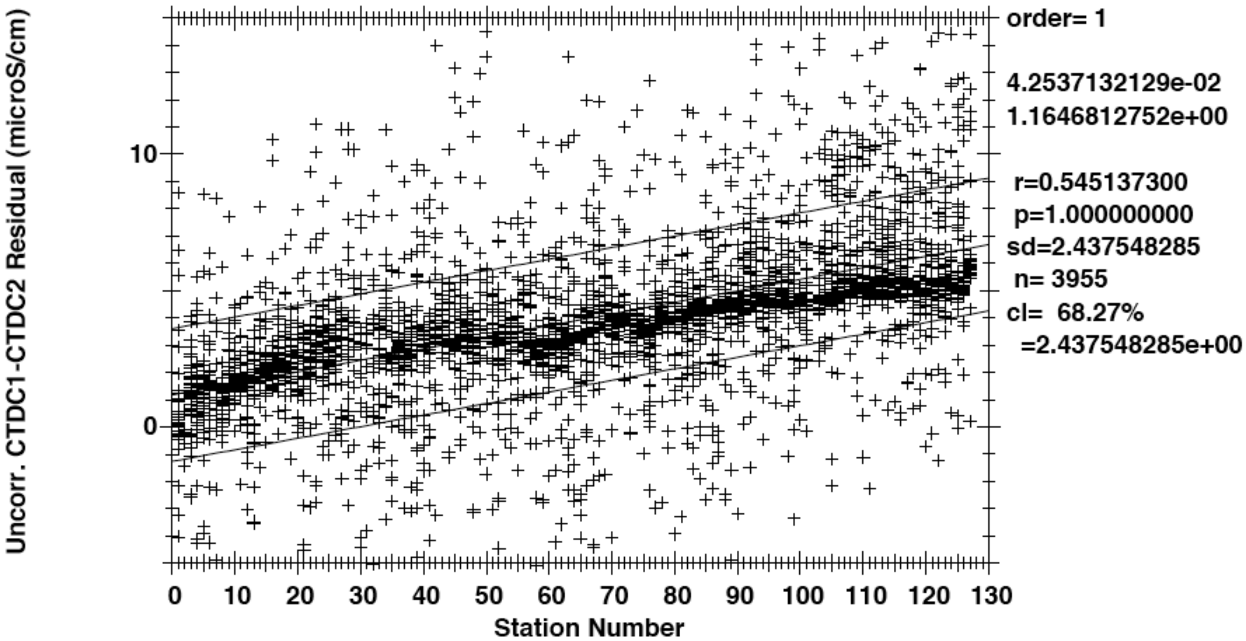

Figure 1.8.3.1: Uncorrected C1-C2 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

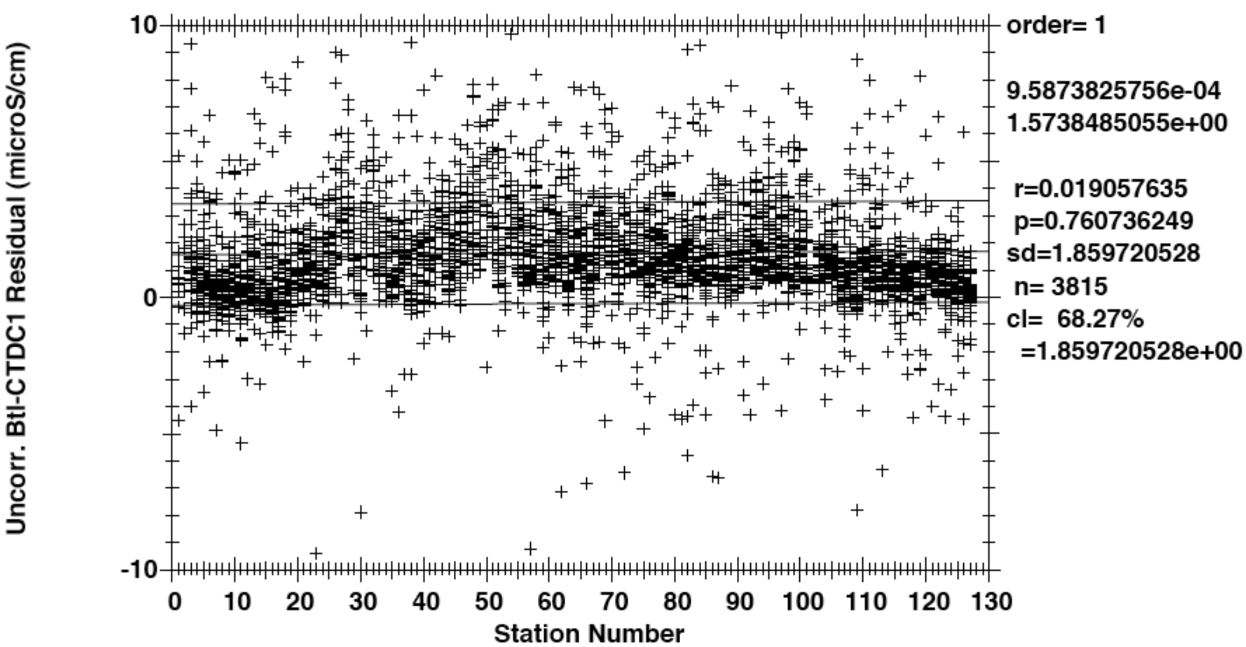

Figure 1.8.3.2: Uncorrected C_{Bottle} - C1 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

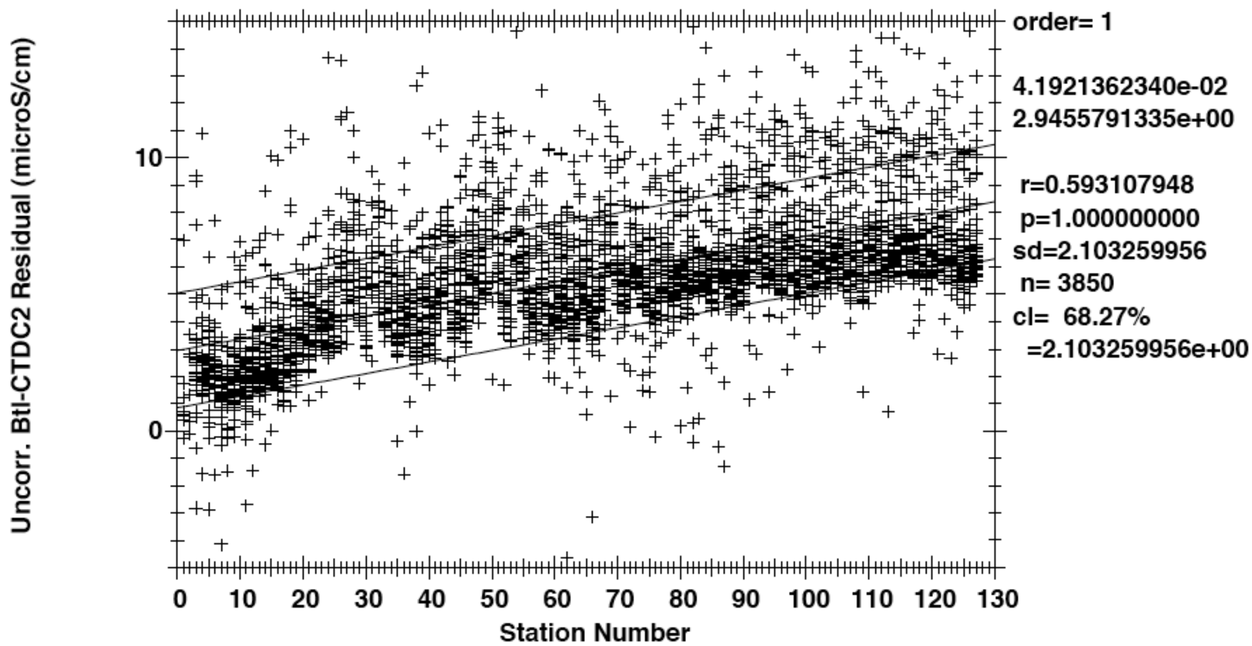

Figure 1.8.3.3: Uncorrected C_{Bottle} - C2 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

Based on C_{Bottle} - C_{CTD} differences in a deep pressure range that would include most stations (2000-3000db), first-order time-dependent drift corrections (changing conductivity offset with time) were determined for each C sensor. C1a (stations 1-102) and C1b (stations 103-127) were grouped separately, and C2 was divided into three station groups, to determine the drift. The rate of change of C2's offset apparently slowed after each one-day delay in station work, so offset drifts were determined for station groups 1-47, 48-97 and 98-127.

After applying the drift corrections, second-order pressure responses were evident for each conductivity sensor. C1a and C1b pressure-dependent corrections were determined separately, using C_{Bottle} - $C1_{CTD}$ differences for all pressures where T1-T2 differences were within ±0.005°C. C_{Bottle} - $C2_{CTD}$ differences would have skewed the deep-end corrections, so Corr.$C1_{CTD}$ - $C2_{CTD}$ differences, for pressures > 500db and T1-T2 differences within ±0.005°C, were used instead to determine C2 pressure-dependent corrections.

C_{Bottle} - C_{CTD} differences were then evaluated for response to temperature and/or conductivity, which typically shifts between pre- and post-cruise SBE laboratory calibrations. Temperature and conductivity responses essentially showed the same picture, so each sensor was fit to conductivity response. Both C1a and C1b required a second-order correction, and C2 required only a slope, vs. C_{CTD}.

After conductivity responses were corrected, the pressure-dependent correction for C1b required a minor adjustment to flatten out the deep end. Drift corrections were re-checked, and it was apparent that C1a required a second-order time-based adjustment to C_{CTD} offsets, instead of the first-order fit initially used.

The residual differences after correction are shown in figures 1.8.3.4 through 1.8.3.12.

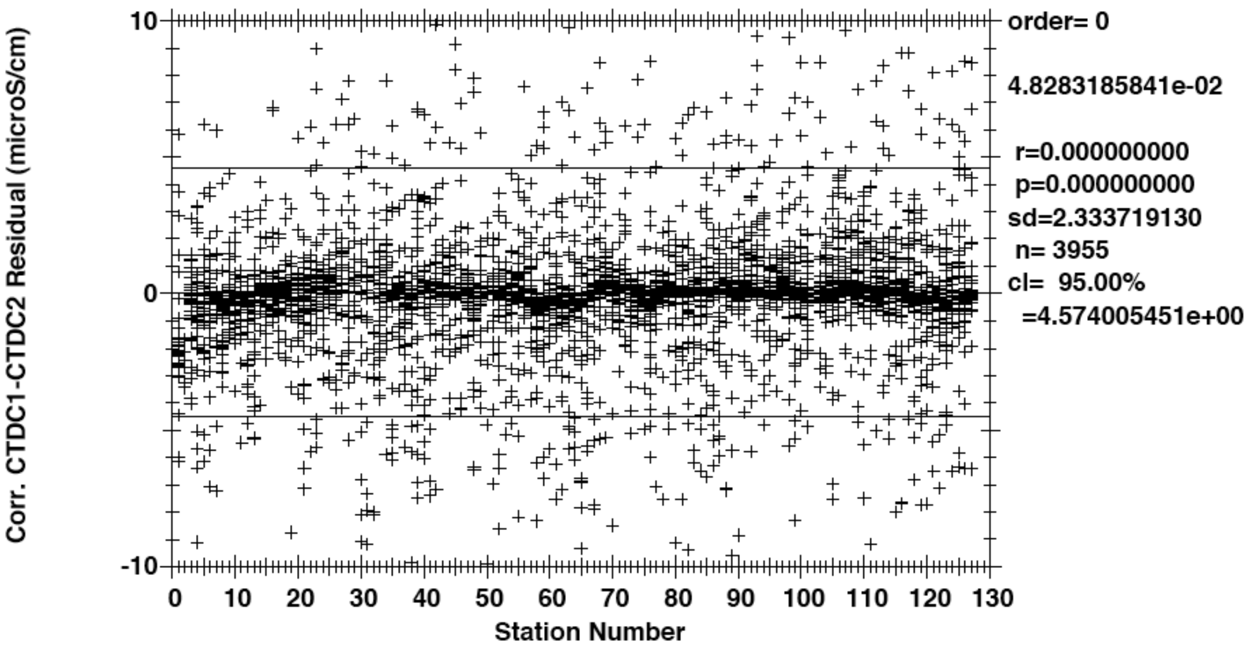

Figure 1.8.3.4: Corrected C1 - C2 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

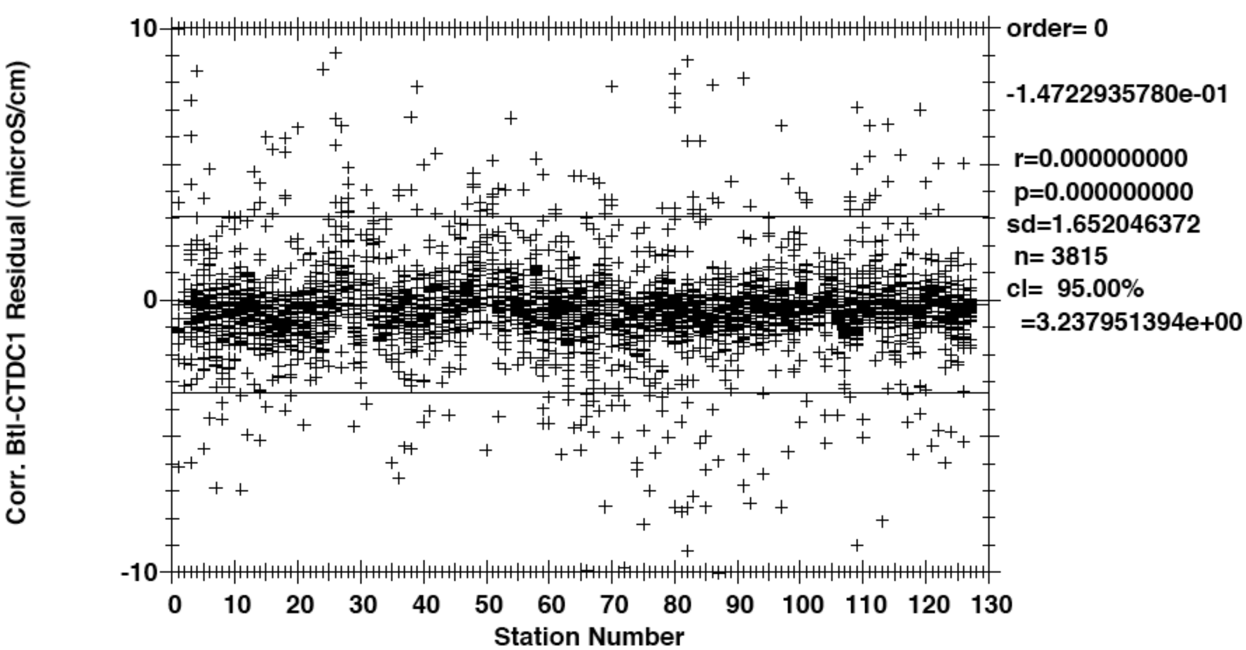

Figure 1.8.3.5: Corrected C_{Bottle} - C1 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

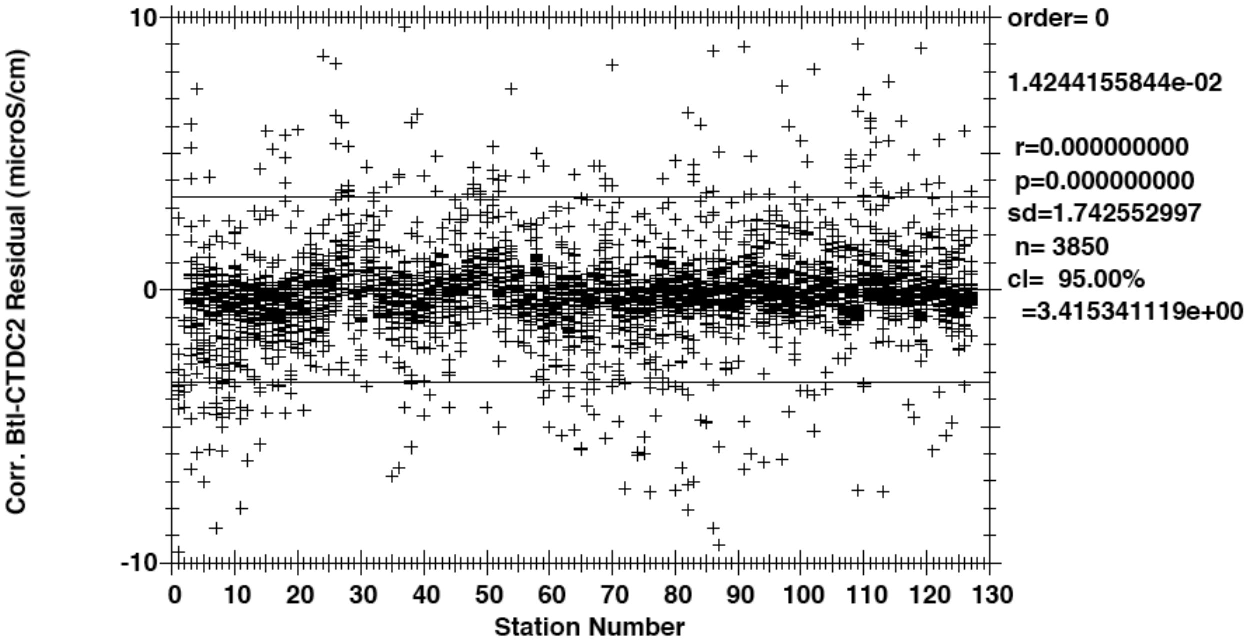

Figure 1.8.3.6: Corrected C_{Bottle} - C2 by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

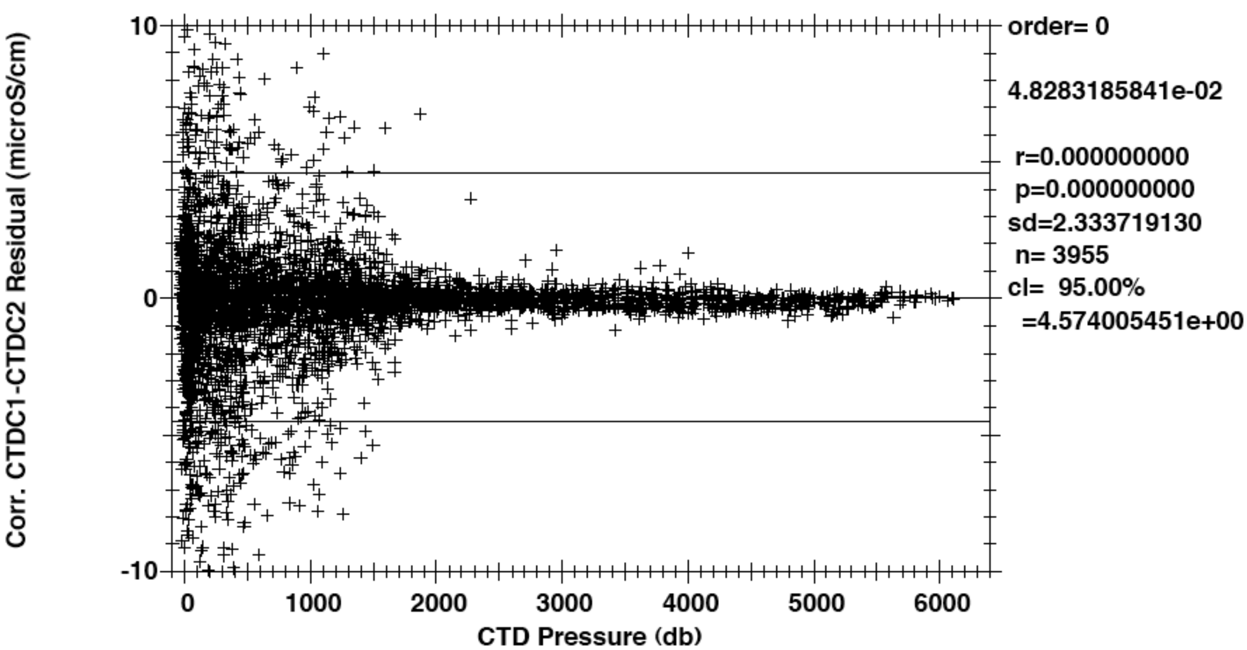

Figure 1.8.3.7: Corrected C1 - C2 by pressure (-0.01°C ≤ T1-T2 ≤ 0.01°C).

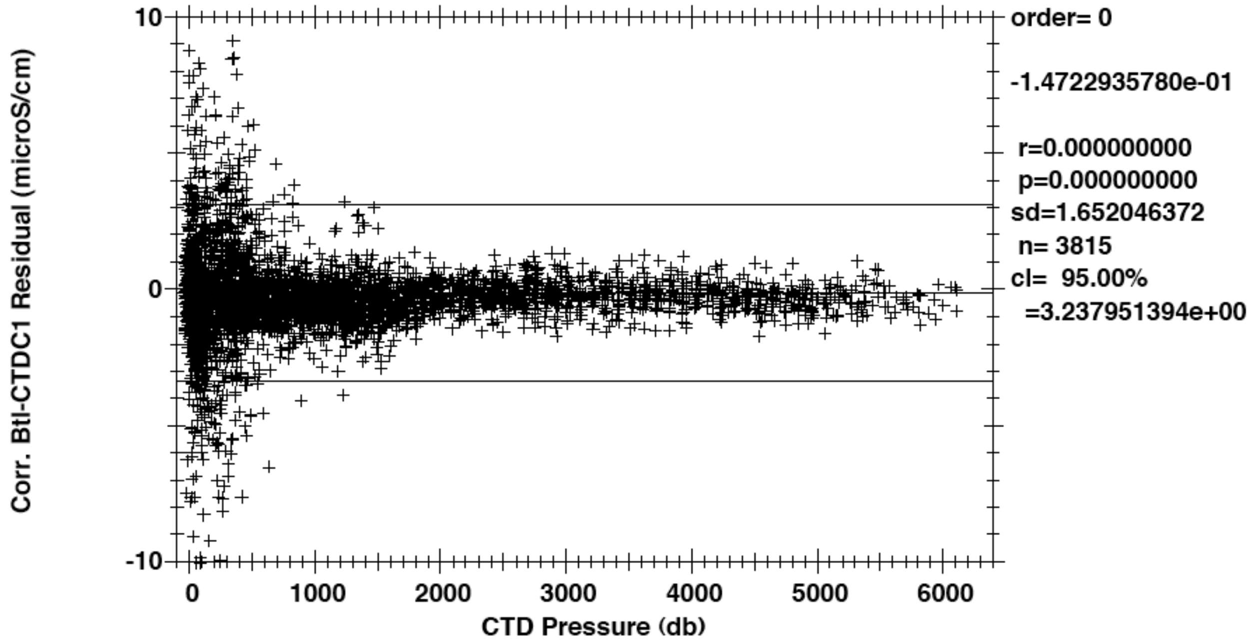

Figure 1.8.3.8: Corrected C_{Bottle} - C1 by pressure (-0.01°C ≤ T1-T2 ≤ 0.01°C).

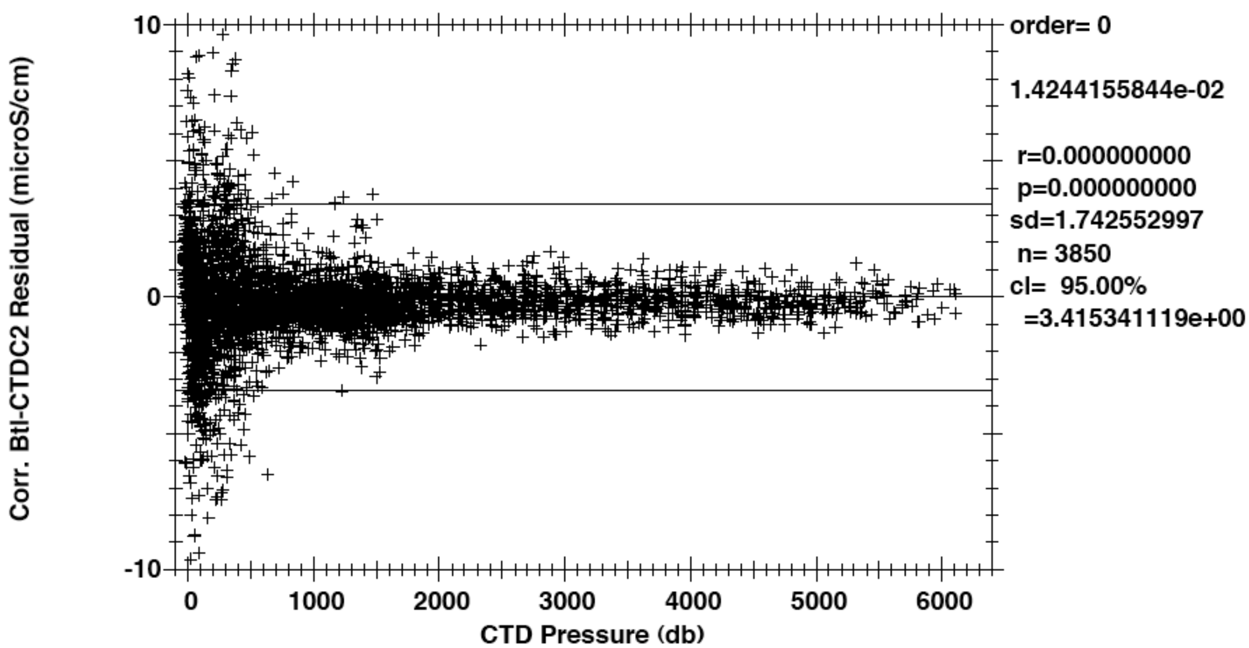

Figure 1.8.3.9: Corrected C_{Bottle} - C2 by pressure (-0.01°C ≤ T1-T2 ≤ 0.01°C).

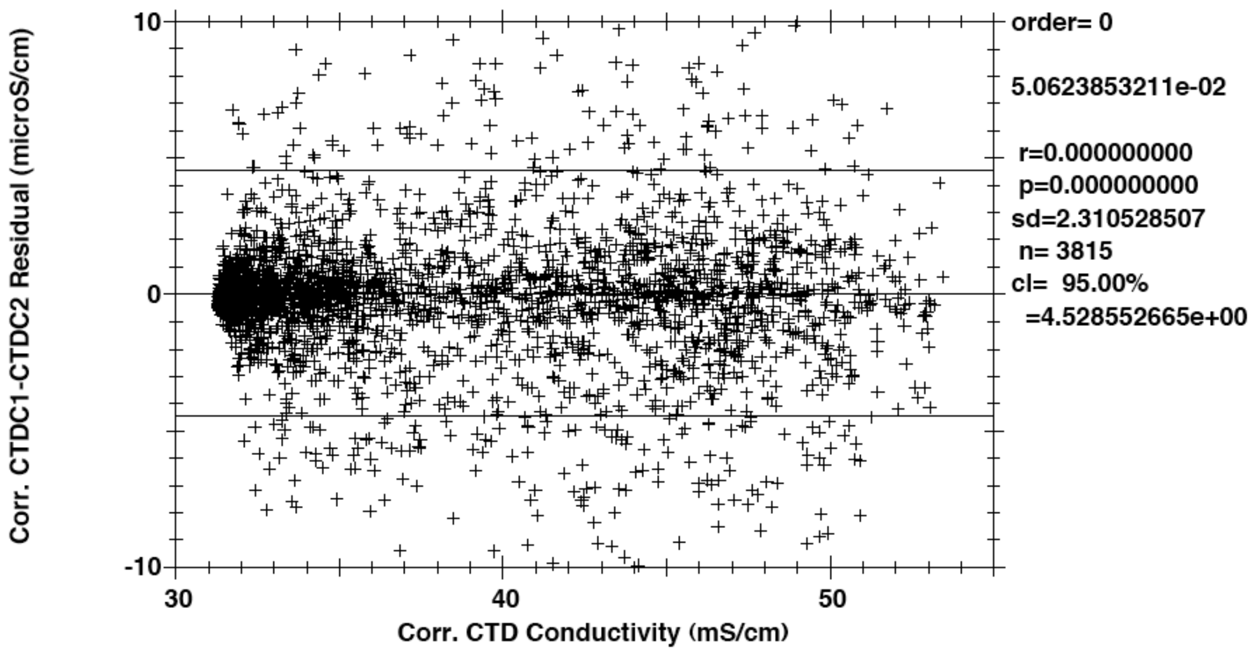

Figure 1.8.3.10: Corrected C1 - C2 by conductivity (-0.01°C ≤ T1-T2 ≤ 0.01°C).

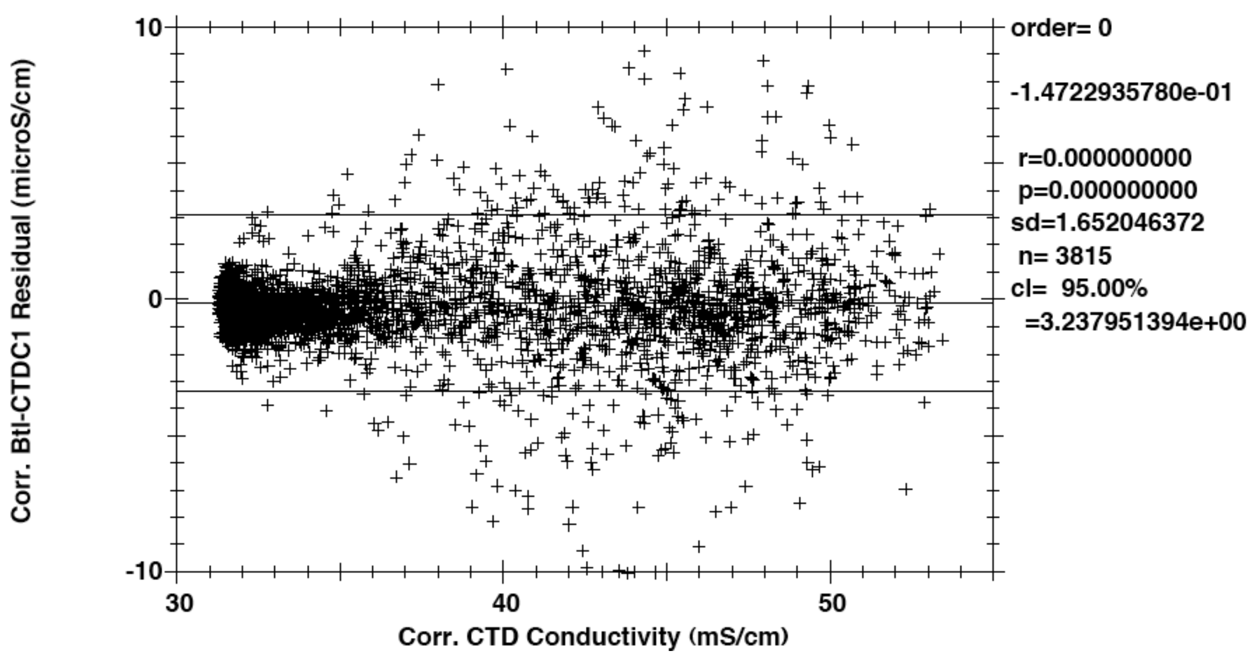

Figure 1.8.3.11: Corrected C_{Bottle} - C1 by conductivity (-0.01°C ≤ T1-T2 ≤ 0.01°C).

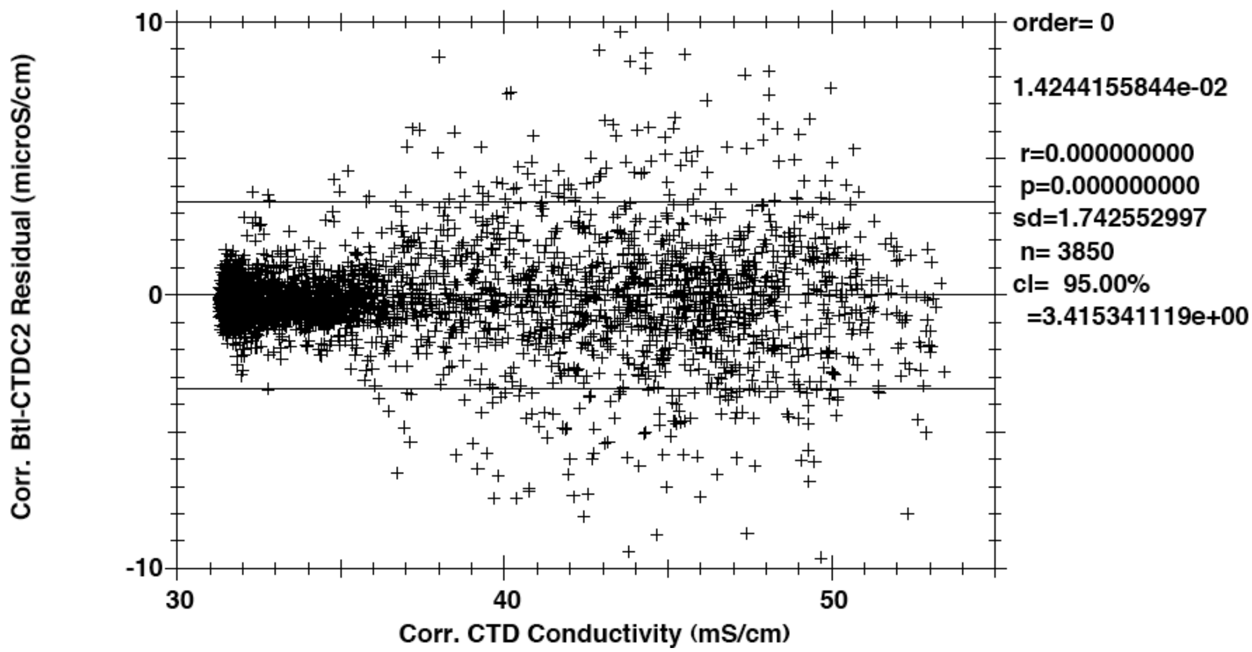

Figure 1.8.3.12: Corrected C_{Bottle} - C2 by conductivity (-0.01°C ≤ T1-T2 ≤ 0.01°C).

The final corrections for all conductivity sensors used on P06 are summarized in Appendix A. Corrections made to all conductivity sensors had the form:

$$C_{cor} = C + cp_2P^2 + cp_1P + cp_0C^2 + c_2C^2 + c_1 + c_0$$

Salinity residuals after applying shipboard P/T/C corrections are summarized in figures 1.8.3.10 through 1.8.3.12. Only CTD and bottle salinity data with "acceptable" quality codes are included in the differences.

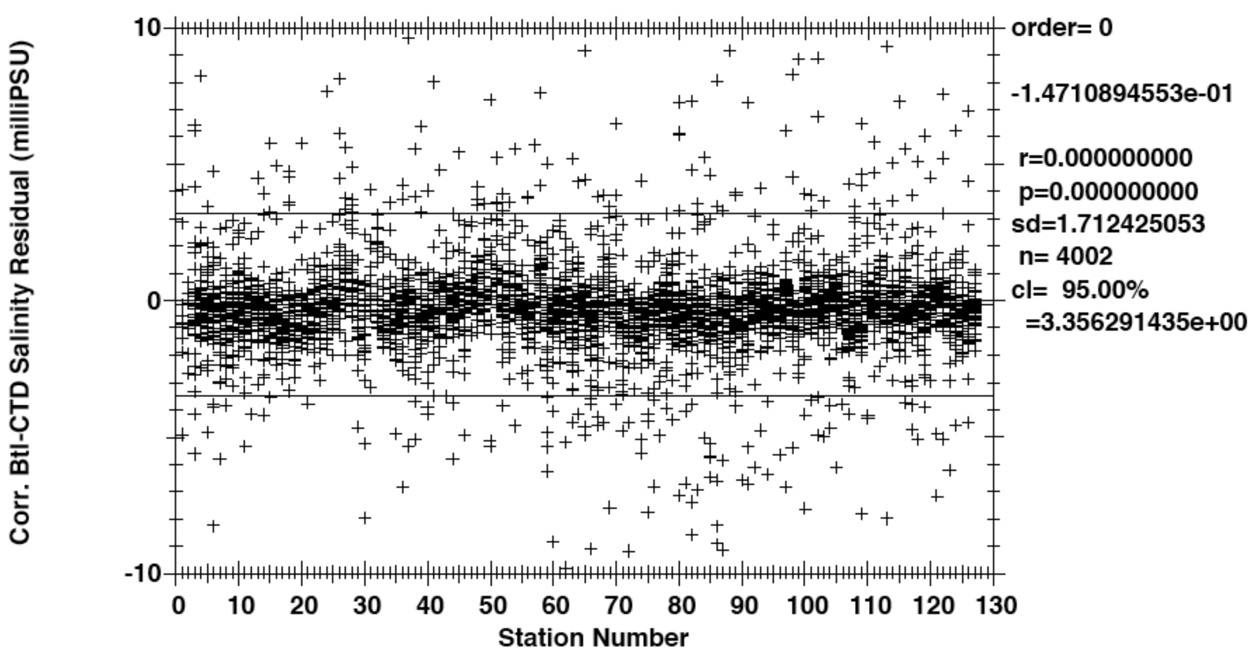

Figure 1.8.3.13: Salinity residuals by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

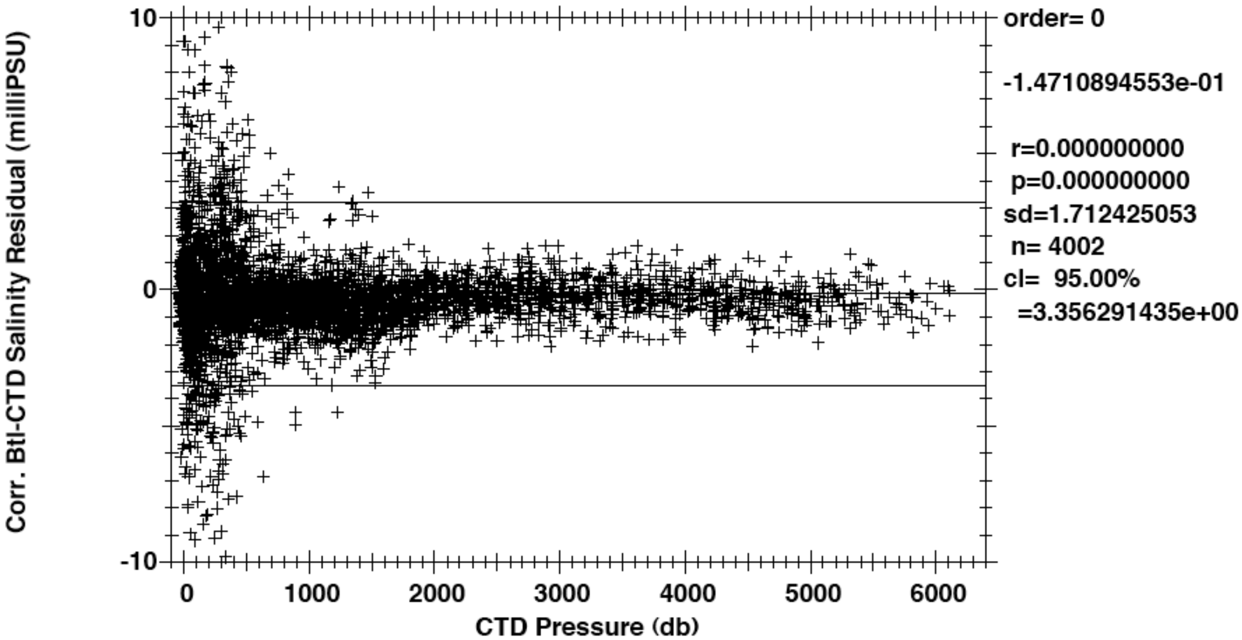

Figure 1.8.3.14: Salinity residuals by pressure (-0.01°C ≤ T1-T2 ≤ 0.01°C).

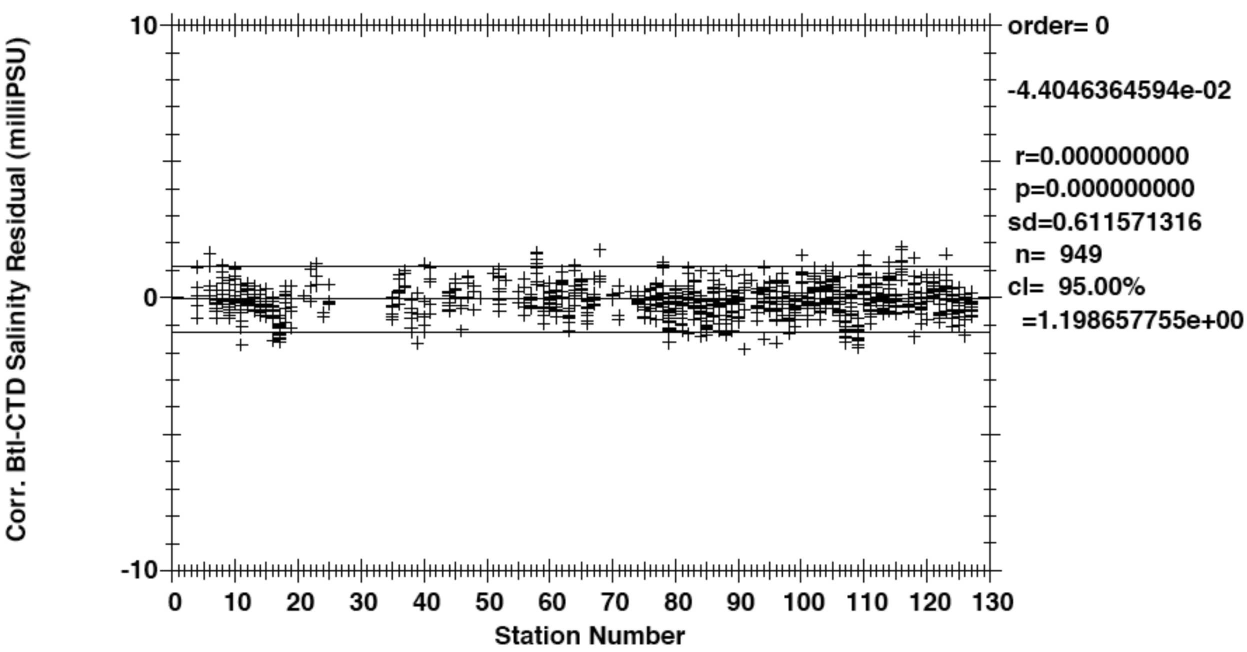

Figure 1.8.3.15: Salinity residuals by station (Pressure>2000db)

Figures 1.8.3.14 and 1.8.3.15 represent estimates of the deep salinity accuracy of CLIVAR P06. The 95% confidence limits are ±0.00120 PSU relative to bottle salinities for deep salinities, and ±0.00335 PSU relative to bottle salinities for all salinities where T1-T2 is within ±0.01°C.

1.8.4. CTD Dissolved Oxygen

A single SBE43 dissolved O2 sensor (DO/43-1508) was used during this leg. The sensor was plumbed into the primary T1/C1 pump circuit after C1.

The DO sensor was calibrated to dissolved O2 check samples taken at bottle stops by matching the down cast CTD data to the up cast trip locations on isopycnal surfaces, then calculating CTD dissolved O2 using a DO sensor response model and minimizing the residual differences from the check samples. A nonlinear least-squares fitting procedure was used to minimize the residuals and to determine sensor model coefficients, and was accomplished in three stages.

The time constants for the lagged terms in the model were first determined for the sensor. These time constants are sensor-specific but applicable to an entire cruise. Next, casts were fit individually to check sample data. Consecutive casts were checked on plots of Theta vs. O2 to check for consistency.

Standard and blank values for check sample oxygen titration data were smoothed, and the oxygen values recalculated, prior to the final fitting of CTD oxygen.

CTD dissolved O2 residuals are shown in figures 1.8.4.0-1.8.4.2.

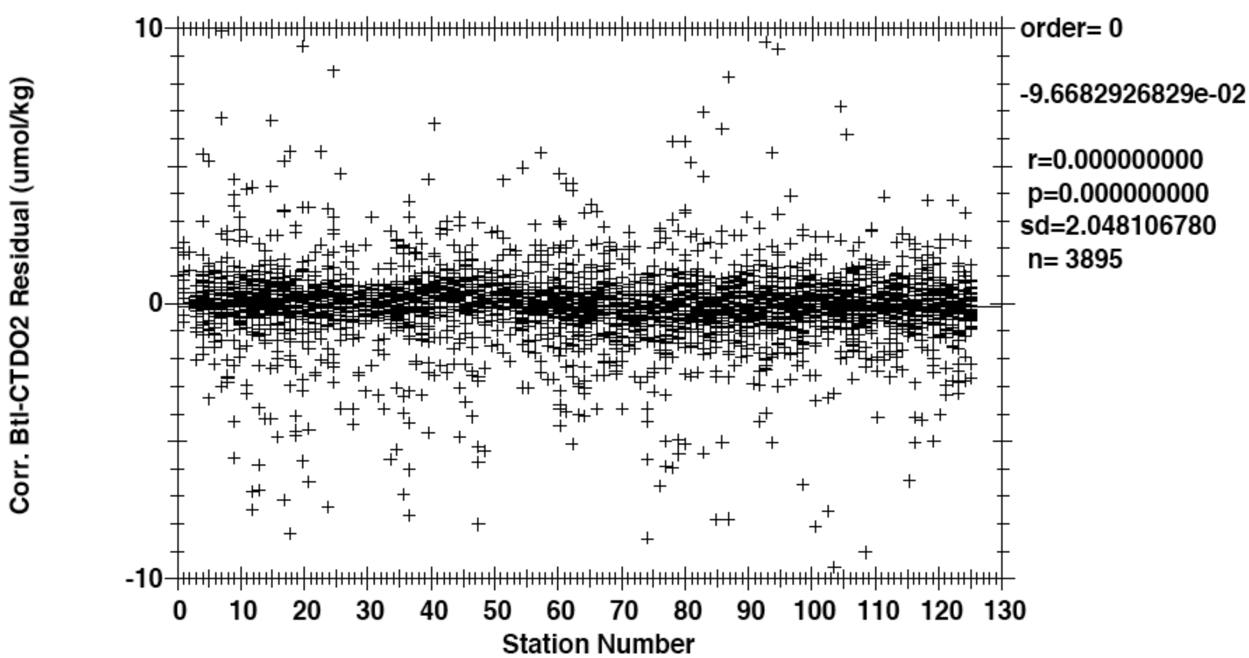

Figure 1.8.4.0: O2 residuals by station (-0.01°C ≤ T1-T2 ≤ 0.01°C).

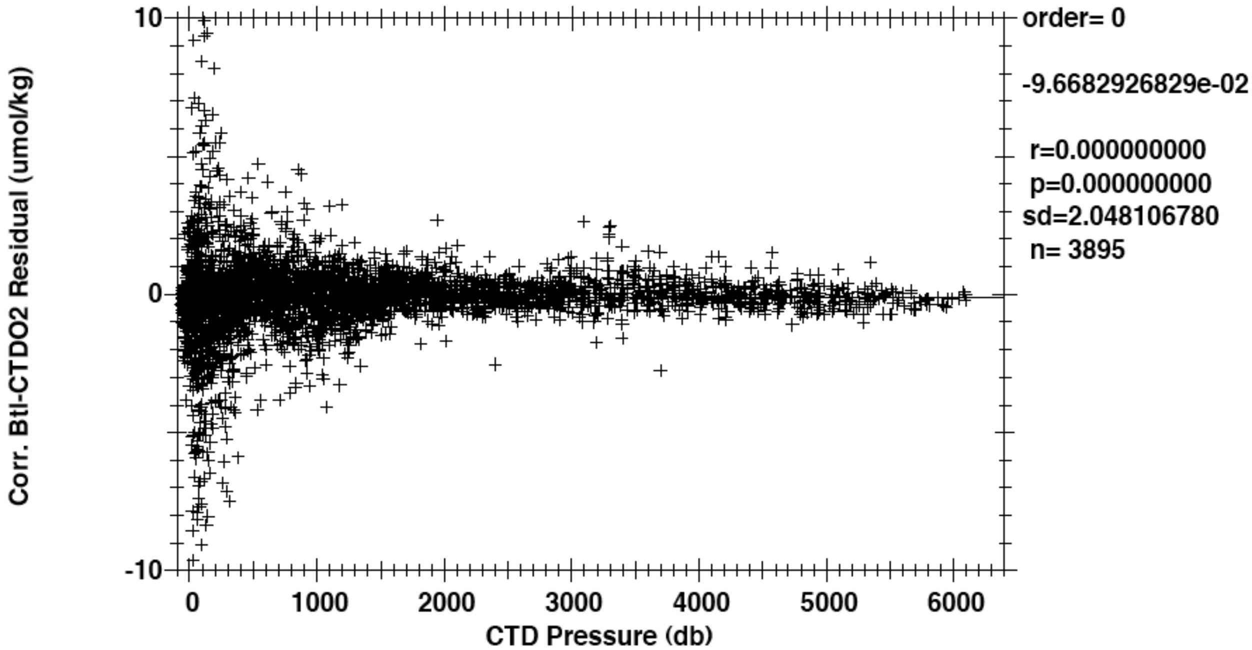

Figure 1.8.4.1: O2 residuals by pressure (-0.01°C ≤ T1-T2 ≤ 0.01°C).

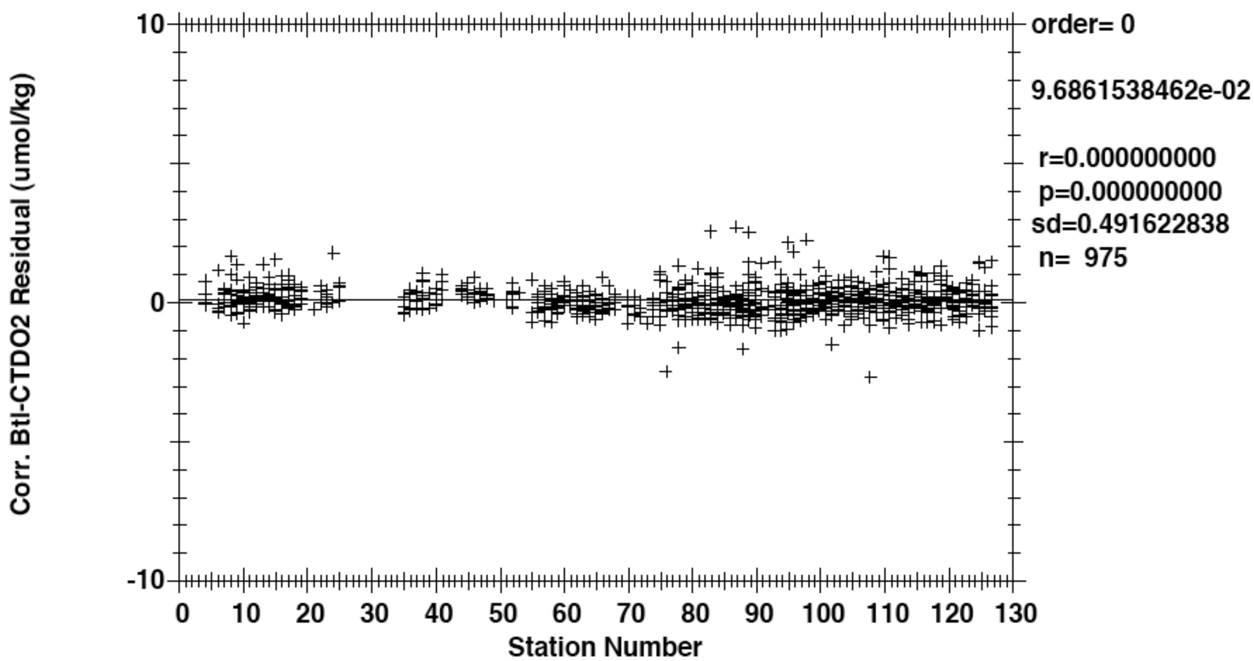

Figure 1.8.4.2: O2 residuals by station (Pressure>2000db).

The standard deviations of 2.05 µmol/kg for all oxygens and 0.49 µmol/kg for deep oxygens are only presented as general indicators of goodness of fit. ODF makes no claims regarding the precision or accuracy of CTD dissolved O2 data.

The general form of the ODF DO sensor response model equation for Clark cells follows Brown and Morrison [Brow78], and Millard [Mill82], [Owen85]. ODF models DO sensor secondary responses with lagged CTD data. In-situ pressure and temperature are filtered to match the sensor responses. Time constants for the pressure response τ(p), a slow (τ(Tf)) and fast (τ(Ts)) thermal response, package velocity (τ(dP)), thermal diffusion (τ(dT)) and pressure hysteresis (τ(h)) are fitting parameters. Once determined for a given sensor, these time constants typically remain constant for a cruise. The thermal diffusion term is derived by low-pass filtering the difference between the fast response (T(s)) and slow response (T(l)) temperatures. This term is intended to correct non-linearities in sensor response introduced by inappropriate analog thermal compensation. Package velocity is approximated by low-pass filtering 1st-order pressure differences, and is intended to correct flow-dependent response. Dissolved O2 concentration is then calculated:

$$O_2ml/l = [C_1 V_{DO} e^{(C_2 \frac{P_h}{5000})} + C_3] \cdot f_{sat}(T,P) \cdot e^{(C_4 T_l + C_5 T_s + C_7 P_l + C_6 \frac{dO_c}{dt} + C_8 \frac{dP}{dt} + C_9 dT)} \tag{1.8.4.0}$$

where:

O_2ml/l	Dissolved O_2 concentration in ml/l;
V_{DO}	Raw sensor output;
C_1	Sensor slope
C_2	Hysteresis response coefficient
C_3	Sensor offset
$f_{sat}(T,P)$	O_2 saturation at T,P (ml/l);
T	insitu temperature (°C);
P	insitu pressure (decibars);
P_h	Low-pass filtered hysteresis pressure (decibars);
T_l	Long-response low-pass filtered temperature (°C);
T_s	Short-response low-pass filtered temperature (°C);
P_l	Low-pass filtered pressure (decibars);
dO_c/dt	Sensor current gradient (µamps/sec);
dP/dt	Filtered package velocity (db/sec);
dT	low-pass filtered thermal diffusion estimate (Ts -Tl).
C_4-C_8	Response coefficients.

1.9. Bottle Sampling

At the end of each rosette deployment water samples were drawn from the bottles in the following order:

- CFC-11, CFC-12, SF_6
- ^{3}He
- O_2
- Dissolved Inorganic Carbon (DIC)
- pH
- Total Alkalinity

- ^{13}C and ^{14}C
- Dissolved Organic Carbon (DOC) and Total Dissolved Nitrogen (TDN)
- Tritium
- Nutrients
- Chromophoric Dissolved Organic Matter (CDOM)
- Chlorophyll a
- Bacterial Cell Count
- Particulate Organic Carbon (POC)
- Del 15N of NO3
- Cyanobacterial DNA, RNA and Cytometry Cell Enumeration
- Salinity
- Millero Density

The correspondence between individual sample containers and the rosette bottle position (1-36) from which the sample was drawn was recorded on the sample log for the cast. This log also included any comments or anomalous conditions noted about the rosette and bottles. One member of the sampling team was designated the sample cop, whose sole responsibility was to maintain this log and insure that sampling progressed in the proper drawing order.

Normal sampling practice included opening the drain valve and then the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log. Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles. Once individual samples had been drawn and properly prepared, they were distributed for analysis. Oxygen, nutrient and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to the data processing computer for centralized data management.

1.10. Bottle Data Processing

Water samples collected and properties analyzed shipboard were centrally managed in a relational database (PostgreSQL 8.1.18) running on a Linux system. A web service (OpenACS 5.3.2 and AOLSer ver 4.5.1) front-end provided ship-wide access to CTD and water sample data. Web-based facilities included on-demand arbitrary property-property plots and vertical sections as well as data uploads and downloads.

The sample log (and any diagnostic comments) was entered into the database once sampling was completed. Quality flags associated with sampled properties were set to indicate that the property had been sampled, and sample container identifications were noted where applicable (e.g., oxygen flask number).

Analytical results were provided on a regular basis by the various analytical groups and incorporated into the database. These results included a quality code associated with each measured value and followed the coding scheme developed for the World Ocean Circulation Experiment Hydrographic Programme (WHP) [Joyc94].

Table 1.10.0 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each basic hydrographic property:

Table 1.10.0: Frequency of WHP quality flag assignments.

Rosette Samples Stations 1 - 127

	Reported Levels	WHP Quality Codes levels 1	2	3	4	5	7	9
Bottle	4156	0	4130	3	5	2	0	16
CTD Salt	4156	0	4156	0	0	0	0	0
CTD Oxy	4102	0	4098	0	4	0	0	54
Salinity	4105	0	4002	96	7	0	0	51
Oxygen	4102	0	4060	27	15	4	0	50
Silicate	4106	0	4091	7	8	1	0	49
Nitrate	4102	0	4054	5	43	5	0	49
Nitrite	4106	0	4099	0	7	1	0	49
Phosphate	4103	0	4054	5	44	4	0	49

Additionally, all WHP water bottle/sample quality code comments are presented in Appendix C. Various consistency checks and detailed examination of the data continued throughout the cruise.

1.11. Salinity

Equipment and Techniques

A single Guildline Autosal 8400B salinometer (S/N 69-180) located in Melville's Photo lab was used for all salinity measurements. This salinometer had been modified to include a communication interface for computer-aided measurement, a higher capacity pump and three temperature sensors. Two of these sensors were used to measure air and bath temperatures. The third was used to check sample bottle temperature.

Samples were analyzed after they had equilibrated to laboratory temperature, usually within 16-20 hours after collection. The salinometer was standardized for each group of analyses (usually 1-2 casts, unto ~48 samples) using at least two fresh vials of standard seawater per group.

Salinometer measurements were aided by computer using software developed by SIO/STS. The software maintained an Autosal log of each salinometer run which included salinometer settings and air and bath temperatures. It also guided the operator through the standardization procedure and making sample measurements. The analyst was prompted to change samples and flush the cells between readings.

Special standardization procedures included flushing the cell at least 4 times with a fresh vial of Standard Seawater (SSW), setting the flow rate as low as possible during the last fill, and monitoring the STD dial setting. If the STD dial changed by 10 units or more since the last salinometer run (or during standardization), another vial of SSW was opened and the standardization procedure repeated to verify the setting.

Samples were run using 3 flushes before the final fill. The computer determined the stability of a measurement and prompted for additional readings if there appeared to be drift. The operator could annotate the salinometer log, and would routinely add comments about cracked sample bottles, loose thimbles, salt crystals or anything unusual in the amount of sample in the bottle.

A system of fans and heaters set up to expedite equilibrating salinity samples usually worked.

Sampling and Data Processing

A total of 4815 salinity measurements were made (709 for Trace Metals) and approximately 288 vials of standard seawater (IAPSO SSW) were used.

Salinity samples were drawn into 200 ml Kimax high-alumina borosilicate bottles, which were rinsed three times with the sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and kept closed with Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Prior to sample collection, inserts were inspected for proper fit and loose inserts replaced to insure an airtight seal. The draw and equilibration times were logged for all casts. Laboratory temperatures were logged at the beginning and end of each run.

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference (usually none) between the initial vial of standard water and the next one run as an unknown was applied as a linear function of elapsed run time to the measured ratios. The corrected salinity data were then incorporated into the cruise database.

Data processing included double checking that the station, sample and box number had been correctly assigned, and reviewing the data and log files for operator comments. The salinity data were compared to CTD salinities and were used for shipboard sensor calibration.

Laboratory Temperature

The salinometer water bath temperature was maintained slightly higher than ambient laboratory air temperature. It was set to 27°C the majority of the stations and to 24°C for stations 46 through 52. The ambient air temperature varied from 21.7 to 28.5°C during the cruise, and from -5.3 to 1.5°C during any particular run.

Standards

IAPSO Standard Seawater Batch P-149 was used to standardize most casts. It was noticed that some of the vials did not have uniform volumes of standard, labels were not put on the vial straight and many of the crimp seals did not release properly, the tab breaking away instead of pulling the sealed section away. These observations raise quality control questions about this batch of Standard Seawater. A recent batch to batch comparison conducted by Dr. Kawano [Kawa09] suggests that P-149 requires a salinity offset of +0.8(^*10-3) relative to other standard batches tested.

Substandard Seawater Analysis

An Autosal standardization procedure using a substandard and cross-laboratory IAPSO batch comparison study was instituted in this expedition. This cross-laboratory effort is in partnership with Andrew Dickson Lab at Scripps Institution of Oceanography. Substandard were run in station sample sets (12 to 48 samples) for stations 31, 36, 38-41, 43, 45-49, 50-58, 60-62, 64-127. Typically substandards were run after IAPSO standard in the beginning of a full station sample set, and/or the substandard was run before the IAPSO standard at the end of station sample set. This analysis was in accordance with Method of Seawater Analysis in Grasshoff et al (1999), and operated to WOCE specifications minimal drifts were noted in associating with substandard.

Analytical Problems

A large drift was identified on stations 7 and 70 attributed to a tainted starting IAPSO standards. A correction of the difference in starting and ending standard conductivity ratios (0.00048, 0.00015 consecutively) was applied to average conductivity ratios for each bottle value. A similar correction was again applied to station 27 after IAPSO Standard Seawater Batch P-151 was used as a final standard instead of P-149. A difference in starting and ending standard conductivity ratios (0.00026) was applied to each bottle value to correct for differences in applied standards.

Results

The estimated accuracy of bottle salinities run at sea is usually better than ±0.002 PSU relative to the particular standard seawater batch used. The 95% confidence limit for residual differences between the bottle salinities and calibrated CTD salinity relative to SSW batch P-149 was ±0.0017 PSU for all salinities, and ±0.0006 PSU for salinities deeper than 2000db.

1 12. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an SIO/ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC LabVIEW software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 mL buret. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson et al. [Culb91], but with higher concentrations of potassium iodate standard (~0.012N) and thiosulfate solution (~55 gm/l). Pre-made liquid potassium iodate standards were run daily (approximately every 2-4 stations), unless changes were made to the system or reagents. Reagent/distilled water blanks were also determined daily or more often if a change in reagents required it to account for presence of oxidizing or reducing agents.

Sampling and Data Processing

4102 oxygen measurements were made from the main rosette and 709 from Trace Metals rosette. Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Three different cases of 36 flasks each were rotated by station to minimize flask calibration issues, if any. Using a Tygon and silicone drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed 3 times with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample drawing temperatures were measured with an electronic resistance temperature detector (RTD) embedded in the drawing tube. These temperatures were used to calculate µmol/kg concentrations, and as a diagnostic check of bottle integrity. Reagents ($MnCl2$ then $NaI/NaOH$) were added to fix the oxygen before stoppering. The flasks were shaken twice (10-12 inversions each time) to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes.

The samples were analyzed within 1-4 hours of collection, and the data incorporated into the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The thiosulfate normalities and blanks were monitored for possible drifting or possible problems when new reagents were used. The thiosulfate normality was found to drift slightly towards higher concentration during the first 37 stations. Upon review, It was determined this was caused by lack of swirling the thiosulfate reservoir thus un-incorporating condensation from the neck of the reservoir and subsequently concentrating the actual liquid titrant. An average blank and linear fit of thiosulfate normality versus Julian day was therefore applied for the first 37 stations and the oxygen values recalculated. There was no indication of drifting blanks or thiosulfate normalities over the remainder of the cruise and an average blank and thiosulfate normality were used to recalculate oxygen concentrations for stations 037 through 127. The difference between the original and "smoothed" data in all cases was less than 0.1%.

Bottle oxygens data was reviewed insuring proper station, cast, bottle number, flask, and draw temperature were entered properly. Any comments made during analysis was also reviewed making certain that any anomalous actions were investigated and resolved. Occasionally, an incorrect end point was encountered. The analyst has the provisions available through the software to check the raw data and have the program recalculated a correct end point. This happened very few times on this data set. The occurrence is usually attributed to debris in the water bath.

After the data is uploaded to the database, oxygen is graphically compared with CTD oxygen and adjoining stations. Any erroneous looking points are reviewed and comments are made regarding the final outcome of the investigation. These investigations and final data coding are reported in Appendix C.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This was done once before using flasks for the first time and periodically thereafter when a suspect volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Liquid potassium iodate standards were prepared in 6 liter batches and bottled in sterile glass bottles at ODF's chemistry laboratory prior to the expedition. The normality of the liquid standard was determined by calculation from weight. The standard was supplied by AlfaAesar (lot B05N35) and has a reported purity of 99.4-100.4%. All other reagents were "reagent grade" and were tested for levels of oxidizing and reducing impurities prior to use.

1.13. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate plus nitrite, and nitrite) were performed on an SIO/STS/ODF-modified 4 channel Technicon AutoAnalyzer II. Modifications to the system include STS/ODF developed data acquisition and processing software using the LabVIEW utility and an interface from the detectors to the computer. The analytical methods used are described by Gordon et al. [Gord92] Hager et al. [Hage68] and Atlas et al. [Atla71]

Silicate

Silicate was analyzed using the technique of Armstrong et al. [Arms67]. An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid was also added to impede PO4 color development. The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

Reagents

Tartaric Acid (ACS Reagent Grade)
200g tartaric acid dissolved in DW and diluted to 1 liter volume.
Stored at room temperature in a polypropylene bottle.
Ammonium Molybdate
10.8g Ammonium Molybdate Tetrahydrate dissolved in 1000ml dilute H2SO4*.
*(Dilute H2SO4 =2.8ml conc. H2SO4 to a liter DW). Added 3 drops 15% ultrapure SDS per liter of solution.
Stannous Chloride (ACS Reagent Grade)
Stock solution:
40g of stannous chloride dissolved in 100 ml 5N HCl.
Refrigerated in a polypropylene bottle.
Working solution:
5 ml of stannous chloride stock diluted to 200 ml final volume with 1.2N HCl. Made up daily and stored at room temperature when not in use in a dark polypropylene bottle.
NOTE: Oxygen introduction was minimized by swirling rather than shaking the stock solution.

Nitrate + Nitrate

A modification of the Armstrong et al. [Arms67] procedure was used for the analysis of nitrate and nitrite. For the nitrate analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. Sulfanilamide was introduced to the sample stream followed by N-(1-naphthyl) ethylenediamine dihydrochloride which coupled to form a red azo dye. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was not present, and a 50mm flowcell was used for measurement.

Reagents

Sulfanilamide (ACS Reagent Grade)
10g sulfanilamide dissolved in 1.2N HCl and brought to 1 liter volume. Added 5 drops of 40% surfynol 465/485 surfactant. Stored at room temperature in a dark polypropylene bottle.
N-(1-Naphthyl)-ethylenediamine dihydrochloride (N-1-N) (ACS Reagent Grade)
1g N-1-N in DIW, dissolved in DW and brought to 1 liter volume. Added 2 drops 40% surfynol 465/485 surfactant. Stored at room temperature in a dark polypropylene bottle. Discarded if the solution turned dark reddish brown.
Imidazole Buffer (ACS Reagent Grade)
13.6g imidazole dissolved in ~3.8 liters DIW. Stirred for at least 30 minutes until completely dissolved. Added 60 ml of CuSO4 + NH4Cl mix (see below). Added 4drops 40% Surfynol 465/485 surfactant. Using a calibrated pH meter, adjusted to pH of 7.83-7.85 with 10%

(1.2N)HCl(about 20-30ml of acid, depending on exact strength).
Final solution brought to 4L with DIW. Stored at room temperature.
NH_4Cl + $CuSO_4$ mix:
2g cupric sulfate dissolved in DIW, brought to 100 ml volume (2%)
250g ammonium chloride dissolved in DIW, brought to 1 liter volume.
Added 5ml of 2% $CuSO_4$ solution to the NH_4Cl stock.
Note: 40% Surfynol 465/485 is 20% 465 plus 20% 485 in DIW.
Prepared solution at least one day before use to stabilize.

Phosphate

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. An acidic solution of ammonium molybdate was added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product was heated to ~55°C to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820nm.

Reagents
Ammonium Molybdate (ACS Reagent Grade)
H_2SO_4 solution:
420 ml of DIW poured into a 2 liter Erlenmeyer flask or beaker, this flask or beaker was placed into an ice bath. SLOWLY added 330 ml of conc. H_2SO_4. This solution gets VERY HOT!!
27g ammonium molybdate dissolved in 250ml of DIW. Brought to 1 liter volume with the cooled sulfuric acid solution. Added 5 drops of 15% ultrapure SDS surfactant. Stored in a dark polypropylene bottle.
Dihydrazine Sulfate (ACS Reagent Grade)
6.4g dihydrazine sulfate dissolved in DIW, brought to 1 liter volume and refrigerated.

Sampling and Data Processing

4106 nutrient samples were analyzed and 709 were analyzed for Trace Metal casts. The cruise started with new pump tubes and then they were changed twice during the cruise, after Stations 25, and 82. Four Beer's Law calibration checks were run throughout the cruise. Four sets of Primary/Secondary standard were made up over the course of the cruise. Primary and secondary standards were compared to the "old" standard before they were used to insure continuity between standards. The cadmium column reduction efficiency was check periodically and ranged between 97%-100% efficiency.

Nutrient samples were drawn into 40 ml polypropylene screw-capped centrifuge tubes. The tubes and caps were cleaned with 10% HCl and rinsed once with de-ionized water and 2-3 times with sample before filling. Samples were analyzed within two hours after sample collection, allowing sufficient time for all samples to reach room temperature. The centrifuge tubes fit directly onto the sampler.

The analog outputs from each of the channels were digitized and logged automatically by computer (PC) at 2-second intervals. After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording which is produced simultaneously with the computer. Refractive Index blanks were determined periodically by measuring the absorbance of low nutrients seawater with one reagent from each of the chemistries offline. The difference between the distilled water baseline and the seawater absorbance was recorded. Sample concentrations were then calculated, refractive index blanks and any non-linear corrections applied, and data merged with other hydrographic measurements. Carryover was minimized by running the samples from low to high concentration. Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), in-situ salinity, and the lab temperature measured when individual samples were drawn into the AA.

Standards and Glassware

Standardizations were performed at the beginning and end of each group of analyses with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. A group usually consisted of one station/cast or two trace metal stations/casts (up to 36 samples). The secondary standards were prepared aboard ship by dilution from the pre-weighed primary standards. A set of 7 different standard concentrations, Table 1.13.0, were analyzed periodically to determine the deviation from linearity, if any, as a function of absorbance for each nutrient. Residuals were determined and fit to a 3rd order polynomial, which was then used to calculate the non-linear corrections applied to the nutrient concentrations. An aliquot from a large volume of stable deep seawater was also run with each set of samples as a substandard and as an additional check.

Table 1.13.0: CLIVAR P06 Standard Concentrations

std	N+N	PO4	SiO3	NO2
1)	0.0	0.0	0.0	0.0
2)	7.75	0.6	30	0.25
3)	15.50	1.2	60	0.50
4)	23.25	1.8	90	0.75
5)	31.00	2.4	120	1.00
6)	38.75	3.0	150	1.25
7)	46.50	3.6	180	1.50

All glass volumetric flasks and pipettes were gravimetrically calibrated prior to the cruise. The primary standards were dried and weighed prior to the cruise. The exact weight was noted for future reference. When primary standards were made, the flask volume at 20°C, the weight of the powder, and the temperature of the solution were used to buoyancy correct the weight, calculate the exact concentration of the solution, and determine how much of the primary was needed for the desired concentrations of secondary standard.

All the reagent solutions, primary and secondary standards were made with fresh distilled deionized water (DIW).

Working standards were made up in low nutrient seawater (LNSW). The first 50L carboy of water used was collected off shore of coastal California and treated in the lab. The water was first filtered through a 0.45 micron filter then re-circulated for ~8hours through a 0.2 micron filter, passed a UV lamp and through a second 0.2 micron filter. Subsequent LNSW used was collected at various stations in clean 40L carboys from the ship's underway system, which provided uncontaminated low nutrient surface water.

The actual concentration of nutrients in this water was empirically determined during the calculation of the non-linear corrections that were applied to the nutrient concentrations.

The Nitrate (KNO3 lot# 042263) and Phosphate (KH2PO4 lot# 991608) primary standards were obtained from Fisher Scientific with reported purities of 100% and 99.8%, respectively. The Silicate (Na2SiF6 lot# J25E26) and Nitrite (NaNO2 lot# K19D12) standards were obtained from Alfa Aesar with reported purities of >98% and 97%.

Quality Control

As is standard ODF practice, a deep calibration check sample was run with each set of sample. Table 1.13.1 is a summary of those calibration check samples.

Table 1.13.1: Calibration check samples

Parameter	AAII concentration
NO3	32.92 uM ±0.28
PO4	2.29 uM ±0.02
SIL	119.49 uM ±1.04

Reference Material for Nutrient Seawater (RMNS)

Lot "BE" RMNS samples (kindly provided by M. Aoyama of Japan Meteorological Research Institute) were run on 114 stations. In addition, 16 calibration sets of four concentrations (lots AS< AX, AZ, and BE) were run throughout the cruise. Table 1.13.1 is a summary of those calibration check samples.

Table 1.13.1: Calibration check samples

Parameter	RMNS concentration
NO3	37.92 uM ±0.31
PO4	2.72 uM ±0.02
SIL	104.25 uM ±0.81

For stability testing purposes, each time a BE sample was run it was stored in the refrigerator and run on the next two subsequent stations. These calibrations sets were also run once "fresh" then stored in the refrigerator and re-run on the subsequent station.

Analytical problems

Station 7 experienced unknown pump surging. This affected the PO4 channel and caused the NO3 cadmium column to air. NO3 and PO4 data was unrecoverable for this station. The PC used to collect data was corrupted between stations 10-12. The computer clock counted seconds within the LabVIEW program in an erratic and unreliable fashion. The computer was switched to a more robust machine after station 12. Peaks for stations 10-12 were read by hand using the cross-hair function of the LabVIEW acquisition program. Other than these issues, no major analytical problems occurred.

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1.14. CFC-11, CFC-12, and SF6

Analysts: Jim Happell, Charlene Grall and Il Nam Kim

Sample Collection

All samples were collected from depth using 10.4 liter Niskin bottles. None of the Niskin bottles used showed a CFC contamination throughout the cruise. All bottles in use remained inside the CTD hanger between casts.

Sampling was conducted first at each station, according to WOCE protocol. This avoids contamination by air introduced at the top of the Niskin bottle as water was being removed. A water sample was collected from the Niskin bottle petcock using Viton tubing to fill a 300 ml BOD bottle. The Viton tubing was flushed of air bubbles. The BOD bottle was placed into a plastic overflow container. Water allowed to fill BOD bottle from the bottom into the overflow container. The stopper was held in the overflow container to be rinsed. Once water started to flow out of the overflow container the overflow container/BOD bottle was moved down so the Viton tubing came out and the bottle was stoppered under water while still in the overflow container. A plastic cap was snapped on to hold the stopper in place. One duplicate sample was taken on most stations from random Niskin bottles. Air samples, pumped into the system using an Air Cadet pump from a Dekoron air intake hose mounted high on the foremast were run when time permitted, and for several days during the long steam to Pappette. Air measurements are used as a check on accuracy.

Equipment and technique

Chlorofluorocarbons CFC-11, CFC-12, and SF6 were measured on approximately 121 stations for a total of 3,848 samples. Analyses were performed on a gas chromatograph (GC) equipped with an electron capture detector (ECD). Samples were introduced into the GC-EDC via a purge and dual trap system. 202 ml water samples were purged with nitrogen and the compounds of interest were trapped on a main Porapak N/Carboxen 1000 trap held at ~ -20oC with a Vortec Tube cooler. After the sample had been purged and trapped for 6 minutes at 250ml/min flow, the gas stream was stripped of any water vapor via a magnesium perchlorate trap prior to transfer to the main trap. The main trap was isolated and heated by direct resistance to 150oC. The desorbed contents of the main trap were back-flushed and transferred, with helium gas, over a short period of time, to a small volume focus trap in order to improve chromatographic peak shape. The focus trap was Porapak N and is held at ~ -20°C with a Vortec Tube cooler. The focus trap was flash heated by direct resistance to 180°C to release the compounds of interest onto the analytical pre-columns. The first precolumn was a 5 cm length of 1/16" tubing packed with 80/100 mesh molecular sieve 5A. This column was used to hold back N2O and keep it from entering the main column. The second pre-column was the first 5 meters of a 60 m Gaspro capillary column with the main column consisting of the remaining 55 meters. The analytical pre-columns were held in-line with the main analytical column for the first 35 seconds of the chromatographic run. After 35 seconds, all of the compounds of interest were on the main column and the pre-column was switched out of line and back-flushed with a relatively high flow of nitrogen gas. This prevented later eluting compounds from building up on the analytical column, eventually eluting and causing the detector baseline signal to increase.

The samples were stored at room temperature and analyzed within 12 hours of collection. Every 12 to 18 measurements were followed by a purge blank and a standard. The surface sample was held after measurement and was sent through the process in order to "restrip" it to determine the efficiency of the purging process.

Calibration

A gas phase standard, 32403, was used for calibration. The concentrations of the compounds in this standard are reported on the SIO 1998 absolute calibration scale. XX calibration curves were run over the course of the cruise. Estimated accuracy is +/- 2%. Precision for CFC-12, CFC-11, and SF6 was less than 1%. Estimated limit of detection is 1 fmol/kg for CFC-11, 3 fmol/kg for CFC-12 and 0.05 fmol/kg for SF6

1.15. Helium and Tritium

Helium and tritium samples were taken roughly every 3-4 degrees for a total of 16 stations.

Helium Sampling

Sampling alternated between taking 24 samples (depths of 0-3300 m) and 32 samples (depths of 0-6400 m) at each station. A duplicate was taken for each station.

Helium samples were taken in stainless steel sample cylinders. The sample cylinders were leak-checked and Back filled with N2 prior to the cruise. Additionally, each cylinder was flushed with N2 just prior to sampling to help eliminate air bubbles. Samples were drawn using Tygon tubing connected to the Niskin bottle at one end and the cylinder at the other. Silicon tubing was used as an adapter to prevent the Tygon from touching the Niskin per the request of the CDOM group. Cylinders are thumped with a bat while being flushed with water from the Niskin to help remove bubbles. After flushing roughly 1 liter of water through them, the plug valves are closed. As the cylinders are sealed by O-ringed plug valves, the samples must be extracted within 24 hours to limit out-gassing.

Eight samples at a time were extracted using our At Sea Extraction line set up in the wet-lab. The stainless steel sample cylinders are attached to the vacuum manifold and pumped down to less than 4e-7 Torr using a diffusion pump for a minimum of 1 hour to check for leaks. The sections are then isolated from the vacuum manifold and introduced to the reservoir cans which are heated to >90°C for roughly 10 minutes. Glass bulbs are attached to the sections and immersed in an individual ice water bath during the extraction process. After 10 minutes each bulb is flame sealed and packed for shipment back to WHOI. The extraction cans and sections are cleaned with distilled water and isopropanol, then dried between each extraction.

Two hundred and sixty-four helium samples were taken; two were lost due to broken glass bulbs. Helium samples will be analyzed using a mass spectrometer at WHOI.

At the beginning of the cruise, the helium extraction line suffered from an ongoing power spike in the van which interfered with maintaining the voltage at a constant 120 volts during extraction. This spike would cause the voltage to exceed the limits of the system and would shut the line down. Many hours were lost due to this and to the fact that it took several hours to get the system up and running again. By putting the voltage on a surge protector and plugging the cord in an outlet on the other side of the van, the spike issue was corrected. The other problem occurred when during a tropical storm, a wave took out the vans AC which put a screeching halt to any more helium extractions.

Tritium Sampling

Sampling alternated between taking 24 samples (0-3300 m) and 32 samples (0-6400 m) at each station. A duplicate was taken at each station.

Tritium samples were taken using a silicon adapter and Tygon tubing to fill 1-qt glass jugs. The jugs were baked in an oven, backfilled with argon, and the caps were taped shut with electrical tape prior to the cruise. While filling, the jugs are place on the deck and filled to about 2 inches from the top of the bottle, being careful not to spill the argon. Caps were replaced and taped shut with electrical tape before being packed for shipment back to WHOI.

456 tritium samples were taken. Tritium samples will be degassed in the lab at WHOI and stored for a minimum of 6 months before mass spectrometer analysis.

No issues were encountered while taking tritium samples.

1.16. Total CO_2 Measurements

Samples for TCO_2 measurements were drawn according to procedures outlined in the Handbook of Methods for CO_2 Analysis (DOE 1994) from 11.7-L Niskin bottles into cleaned 294-mL glass bottles. Bottles were rinsed and filled from the bottom, leaving 6 mL of headspace; care was taken not to entrain any bubbles. After 0.2 mL of saturated HgCl2 solution was added as a preservative, the sample bottles were sealed with glass stoppers lightly covered with Apiezon-L grease and were stored at room temperature for a maximum of 12 hours prior to analysis.

TCO_2 samples were collected from variety of depths with one to three replicate samples. Typically the replicate seawater samples were taken from the surface, around 1000 m and bottom Niskin bottles, and run at different times during the cell. No systematic difference between the replicates was observed.

The TCO_2 analytical equipment was set up in a seagoing laboratory van. The analysis was done by coulometry with two analytical systems (AOML3 and AOML4) used simultaneously on the cruise. Each system consisted of a coulometer (UIC, Inc.) coupled with a Dissolved Inorganic Carbon Extractor (DICE) inlet system. DICE was developed by Esa Peltola and Denis Pierrot of NOAA/AOML and Dana Greeley of NOAA/PMEL to modernize a carbon extractor called SOMMA (Johnson et al. 1985, 1987, 1993, and 1999; Johnson 1992). In the coulometric analysis of TCO_2, all carbonate species are converted to CO_2 (gas) by addition of excess hydrogen ion (acid) to the seawater sample, and the evolved CO_2 gas is swept into the titration cell of the coulometer with pure air or compressed nitrogen, where it reacts quantitatively with a proprietary reagent based on ethanolamine to generate hydrogen ions. In this process, the solution changes from blue to colorless, which triggers a current through the cell and causes coulometrical generation of OH– ions at the anode. The OH– ions react with the H+, and the solution turns blue again. A beam of light is shone through the solution, and a photometric detector at the opposite side of the cell senses the change in transmission. Once the percent transmission reaches its original value, the coulometric titration is stopped, and the amount of CO_2 that enters the cell is determined by integrating the total charge during the titration.

The coulometers were calibrated by injecting aliquots of pure CO_2 (99.99%) by means of an 8-port valve outfitted with two sample loops with known gas volumes bracketing the amount of CO_2 extracted from the water samples for the two AOML systems.

The stability of each coulometer cell solution was confirmed three different ways: two sets of gas loops were measured at the beginning; also the Certified Reference Material (CRM), Batches 86 and 96, supplied by Dr. A. Dickson of SIO, were measured at the beginning; and the duplicate samples at the beginning, middle, and end of each cell solution. The coulometer cell solution was replaced after 25 mg of carbon was titrated, typically after 9–12 hours of continuous use.

The pipette volume was determined by taking aliquots at known temperature of distilled water from the volumes. The weights with the appropriate densities were used to determine the volume of the pipettes.

Calculation of the amount of CO_2 injected was according to the CO_2 handbook (DOE 1994). The concentration of CO_2 ($[CO_2]$) in the samples was determined according to:

$$[CO_2] = \text{Cal. factor} * \frac{(\text{Counts - Blank * Run Time}) * K\ \mu\text{mol/count}}{\text{pipette volume * density of sample}}$$

where Cal. Factor is the calibration factor, Counts is the instrument reading at the end of the analysis, Blank is the counts/minute determined from blank runs performed at least once for each cell solution, Run Time is the length of coulometric titration (in minutes), and K is the conversion factor from counts to μmol.

The instrument has a salinity sensor, but all TCO_2 values were recalculated to a molar weight (μmol/kg) using density obtained from the CTD's salinity. The TCO_2 values were corrected for dilution by 0.2 mL of saturated HgCl2 used for sample preservation. The total water volume of the sample bottles was 288 mL (calibrated by Esa Peltola, AOML). The correction factor used for dilution was 1.0007. A correction was also applied for the offset from the CRM. This correction was applied for each cell using the CRM value obtained in the beginning of the cell. The average correction was 3.1 μmol/kg. The results underwent initial quality control on the ship using TCO_2-pressure/ salinity/ oxygen/ phosphate/ nitrate/ silicate/ alkalinity and pH plots. Also vertical sections were used for the quality control.

The overall performance of the instruments was good during the cruise. There were some problems with the valves and fittings: the valve 13 failed a couple of times on both machines and the nylon fittings between the stripper and drying bulb deteriorated. The modified Ultra-Torr fittings around the ORBO tubes leaked due to too small o-rings: the ORBO tube was not used on DICE3, but due to low pressure on DICE4 it was in line with 1/8" Swagelok to 1/4" tube fittings and 1/4" Bio-Chem tubing. In the beginning of the cruise the water bath stopped cooling and it was replaced. The Field Point communication crashed and the coulometers jammed a couple of times. The ship had grounding problems and the van's AC and some power strips broke at the station 26. The AC unit was replaced with a spare one.

2918 samples were analyzed for discrete dissolved inorganic carbon. The total dissolved inorganic carbon data reported to the database directly from the ship are to be considered preliminary until a more thorough quality assurance can be completed shore side.

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1.17. Discrete pH Analyses

Sampling

Samples were collected in 50ml borosilicate glass syringes rinsing a minimum of 2 times and thermostated to 25°C before analysis. Two duplicates were collected from each station. Samples were collected on the same bottles as total alkalinity or dissolved inorganic carbon in order to completely characterize the carbon system. All data should be considered preliminary.

Analysis

pH (µmol/kg H2O) on the seawater scale was measured using a Agilent 8453 spectrophotometer according to the methods outlined by Clayton and Byrne (1993). A RTE17 water bath maintained spectrophotometric cell temperature at 25.0°C. A 10cm flow through cell was filled automatically using a Kloehn 6v syringe pump. The sulfonephthalein indicator m-cresol purple (mCP) was also injected automatically by the kloehn 6v syringe pump into the spectrophotometric cells, and the absorbance of light was measured at three different wavelengths (434 nm, 578 nm, 730 nm). The ratios of absorbances at the different wavelengths were input and used to calculate pH on the total and seawater scales, incorporating temperature and salinity into the equations. The equations of Dickson and Millero (1987), Dickson and Riley (1979), and Dickson (1990) were used to convert pH from total to seawater scales. Salinity data were obtained from the conductivity sensor on the CTD. These data were later corroborated by shipboard measurements. Temperature of the samples was measured immediately after spectrophotometric measurements using a Guildline 9540 digital platinum resistance thermometer.

Reagents

The mCP indicator dye was a concentrated solution of 2.0 mM with an R = 1.61350.

Standardization

The precision of the data can be accessed from measurements of duplicate samples, certified reference material (CRM) Batch 96 (Dr. Andrew Dickson, UCSD) and TRIS buffers. CRMs were measured approximately every other day and TRIS buffers were measured approximately once a day. The mean and standard deviation for the CRMs was 7.8845± 0.0140 (n=17) and 8.1086±0.0106 (n=37) for TRIS buffer.

Data Processing

Addition of the indicator affects the pH of the sample, and the degree to which pH is affected is a function of the pH difference between the seawater and indicator. Therefore, a correction is applied for each batch of dye. To obtain this correction factor, all samples throughout the cruise were measured after two consecutive additions of mCP. From these two measurements, a change in absorbance ratio per mL of mCP indicator is calculated. R was calculated using the absorbance ratio (Rm) measured after the initial indicator addition from:

$$R = Rm + (-0.00173 + 0.000382\ Rm)\ Vind\ (1)$$

$$R = Rm + (-0.00254 + 0.000571\ Rm)\ Vind\ (2)$$

where Vind is the volume of mCP used. Clayton and Byrne (1993) calibrated the mCP indicator using TRIS buffers (Ramette et al. 1977) and the equations of Dickson (1993). These equations are used to calculate pH t, the total scale in units of moles per kilogram of solution.

Table 1: Preliminary Quality Control

Total Number of Samples	3098
Questionable (QC=3)	95
Bad (QC=4)	145
Lost (QC=5)	22
Duplicate (QC=6)	401

Problems

This was the first time we used the automated system at sea and there were a few bugs in the computer program. About station 47 the blank became very noisy. The cell was rinsed with 3m HCl, acetone, and Milli-Q water. After this the cell was rinsed 2 to 3 times throughout the cast with Milli-Q water, and if the blank became noisy the cell was left to soak in Milli-Q water for 1-2 hours before analysis continued. Two of the Kloehn syringe pumps died during station 62, 68, and 79. This caused these stations to be skipped. Since the backup Kloehn for the automated sampler had to be used as the main syringe pump samples had to be run individually. During analysis of station 96 rough seas caused the water baths to over flow profusely. Analysis was halted until calmer seas, and the replacement of the tungsten lamp in the spectrophotometer. This caused almost 24 hours between collection and analysis for most of station 96.

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1.18. Total Alkalinity Analyses

Sampling

The sampling scheme was roughly an alternation between full (36 Niskins) on even stations and partial (18 Niskins) on odd stations. All casts had 3 duplicate samples drawn; one from the near the bottom, oxygen minimum, and surface Niskin. Samples were drawn from Niskin bottles into 500 ml borosilicate flasks using silicone tubing that fit over the petcock to avoid contamination of DOC samples. Bottles were rinsed a minimum of two times and filled from the bottom, overflowing half of a volume while taking care not to entrain any bubbles. Approximately 15 ml of water was withdrawn from the flask by arresting the sample flow and removing the sampling tube, thus creating a small expansion volume and reproducible headspace. The sample bottles were sealed at a ground glass joint with a glass stopper. The samples were thermostated at 25°C before analysis.

Table 1: Preliminary Quality control for Total Alkalinity

Total Number of Samples	3525
Questionable (QC=3)	50
Bad (QC=4)	109
Lost (QC=5)	43
Duplicate (QC=6)	696

Analyzer Description

The total alkalinity of seawater (TAlk) was evaluated from the proton balance at the alkalinity equivalence point, pHequiv = 4.5 at 25°C and zero ionic strength in one kilogram of sample. The method utilizes a multi-point hydrochloric acid titration of seawater according to the definition of total alkalinity (Dickson 1981). The potentiometric titrations of seawater not only give values of TAlk but also those of DIC and pH, respectively from the volume of acid added at the first end point and the initial emf, E0. Two titration systems, A and B were used for TAlk analysis. Each of them consists of a Metrohm 665 Dosimat titrator, an Orion 720A pH meter and a custom designed plexiglass water-jacketed titration cell (Millero et al, 1993). Both the seawater sample and acid titrant were temperature equilibrated to a constant temperature of 25 ± 0.1°C with a water bath (Neslab, model RTE-17). The water-jacketed cell is similar to the cells used by Bradshaw and Brewer (1988) except a larger volume (~200 ml) is employed to increase the precision. Each cell has a fill and drain valve which increases the reproducibility of the volume of sample contained in the cell. A typical titration recorded the EMF after the readings became stable (deviation less than 0.09 mV) and then enough acid was added to change the voltage a pre-assigned increment (13 mV). A full titration (~25 points) takes about 15-20 minutes. The electrodes used to measure the EMF of the sample during a titration consisted of a ROSS glass pH electrode (Orion, model 810100) and a double junction Ag, AgCl reference electrode (Orion, model 900200).

Reagents

A single 50-l batch of ~0.25 m HCl acid was prepared in 0.45 m NaCl by dilution of concentrated HCl, AR Select, Mallinckrodt, to yield a total ionic strength similar to seawater of salinity 35.0 (I ≈ 0.7 M). The acid was standardized by a coulometric technique (Marinenko and Taylor, 1968; Taylor and Smith, 1959) and verified with alkalinity titrations on seawater of known; alkalinity. The calibrated molarity of the acid used was 0.24178 ± 0.0001 M HCl. The acid was stored in 500-ml glass bottles sealed with Apiezon® L grease for use at sea. Standardization

The volumes of the cells used were determined to ±0.03 ml during the initial set up by multiple titrations using seawater of known total alkalinity and CRM. The cell for system B was replaced at station 28 and calibrated before analyzing any samples. Calibrations of the burette of the Dosimat with water at 25°C indicate that the systems deliver 3.000 ml (the approximate value for a titration of 200 ml of seawater) to a precision of ± 0.0004 ml, resulting in an error of ± 0.3 µmol/kg in TAlk. The reproducibility and precision of measurements are checked using low nutrient surface seawater and Certified Reference Material (Dr. Andrew Dickson, Marine Physical Laboratory, La Jolla, California), Batch 86 and 86. CRM's were utilized in order to account for instrument drift and to maintain measurement precision. Opened CRM bottles, referred to as "old" were provided by the DIC analysts. Duplicate analyses provide additional quality assurance and were taken from the same Niskin bottle. Duplicates were either both measured on system A, both on system B, or one each on A and B. Data Processing

An integrated program controls the titration, data collection, and the calculation of the carbonate parameters (TAlk, pH, and DIC). The program is patterned after those developed by Dickson (1981), Johansson and Wedborg (1982), and U. S. Department of Energy (DOE) (1994). The program uses a Levenberg-Marquardt nonlinear least-squares algorithm to calculate the TAlk, DIC, and from the potentiometric titration data.

Table 2: Comparison of measured and Certified CRM (Batch 96) values

	Instrument A	Instrument B
Mean	-0.14	1.57
Standard Deviation	2.52	2.30
Number	38	36

Table 3: Comparison of the duplicates on both instruments

	Instrument A	Instrument B	Instrument(A-B)
Mean	0.08	-0.09	-0.27
Standard Deviation	1.94	1.13	2.30
Number	115	113	87

Problems

No major problems occurred throughout the cruise. During a rough storm around station 96 the rocking of the ship caused the water baths to over flow profusely and analysis was halted until calmer seas. This caused approximately 14 hours between collection and analysis for station 96.

References

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1.19. Dissolved Organic Matter and Bacterial Samples

PI: C. Carlson, University of California, Santa Barbara
Cruise Participants: Rachel Henry, University of California, Santa Barbara
Support: NSF

Project Goals

The goal of the DOM project is to evaluate dissolved organic carbon (DOC) and total dissolved nitrogen (TDN) concentrations over along the P6 south Pacific line. During the P6 cruise, casts were specifically targeted in order to overlap with the TCO_2 sampling program.

Dissolved Organic Carbon and Total Dissolved Nitrogen (DOC/TDN)

DOC profiles were taken at approximately every other station (~1400 samples). Depending on the station depth, 12 – 36 Niskin bottles were sampled following directly behind the TCO_2 sample draw. DOC samples were passed through an inline filter holding a combusted GF/F filter attached directly to the Niskin for samples in the top 500 m of each cast. This was done to eliminated particles > than 0.7 µm from the sample. Samples from deeper depths were not filtered. Previous work has demonstrated that there is no resolvable difference between filtered and unfiltered sample in waters below the upper 200 m at the µmol kg-1 resolution. High density polyethylene 60 ml sample bottles were 10% HCl cleaned and Mili-Q water rinsed. Filters were combusted at 450°C for overnight. Filter holders were 10% HCl cleaned and Mili-Q water rinsed. Samples were introduced into the sample bottles via pre-cleaned silicone tubing. Bottles were rinsed by sample for 3 times before filling. 40-50 ml of water were taken for each sample. Samples were kept frozen at -20C in the ship's freezer. Frozen samples will be shipped back by express shipping to UC Santa Barbara for analysis. All samples will be analyzed via the high temperature combustion technique on a Shimadzu TOC-V analyzer. DOC analyses are expected to be complete within approximately 12 months of their return to the laboratory. TDN samples will be analyzed for the surface 200 m from the same DOC sample bottle.

Bacterial Abundance via Flow Cytometry

We also concurrently collect samples for bacterial abundance to compare the distribution to that of CDOM and DOC. We collected 1 profile per day, up to 22 samples, 15 ml per sample. They are prepped under fume hood, and stored in the ship's -80C freezer. Frozen samples will be shipped back by express shipping to UC Santa Barbara for analysis. Sample will be analyzed using a BD LSR II Flow cytometer.

1.20. Carbon Isotopes.

14C – DIC

Sampling was conducted for Ann McNichol's group from WHOI.

14C samples were taken at ~ every 4 – 8 stations; deep and shallow profiles were interspersed along the transect. 14 stations were sampled in total. Bottles were cleaned at WHOI before the cruise. Samples were taken and sealed for storage according to the instructions provided by WHOI[1]. Samples will be shipped back to WHOI for 14C analyses.

[1]Measuring 14C in seawater total CO_2 will be performed by accelerator mass spectrometry, according to WHP Operation and Methods,

1.21. Chromophoric DOM - A Photoactive Tracer of Geochemical Process

PIs: N. Nelson, D. Siegel, C. Carlson, University of California, Santa Barbara
Support: NASA Ocean Biology and Biogeochemistry; NSF Chemical Oceanography
Field Team (P6 Leg 1): Chantal Swan (Post-doc), K. G. Fairbarn (Technician)
Field Team (P6 Leg 2): Norm Nelson (PI), K. G. Fairbarn (Technician)

Project Goals:

Our goals are to determine chromophoric dissolved matter (CDOM) distributions over a range of oceanic regimes on selected sections of the CO_2/CLIVAR Repeat Hydrography survey, and to quantify and parameterize CDOM production and destruction processes with the goal of mathematically constraining the cycling of CDOM. CDOM is a poorly characterized organic matter pool that interacts with sunlight, leading to the photoproduction of climate-relevant trace gases, attenuation of solar ultraviolet radiation in the water column, and an impact upon ocean color that can be quantified using satellite imagery. We believe that the global distribution of CDOM in the open ocean is controlled by microbial production and solar bleaching in the upper water column, and relative rates of advection and remineralization in intermediate and deep waters. Furthermore, changes in the optical properties of CDOM and its relationship with DOC over time suggest the use of CDOM as an indicator of the prevalence of refractory DOC in the deep ocean. We are testing these hypotheses by a combination of field observation and controlled experiments. We are also interested in the deep-sea reservoir of CDOM and its origin and connection to surface waters and are making the first large-scale survey of the abundance of CDOM in the deep ocean.

Activities on P6:

Profiling Instruments

Once each day we cast a hand-deployed free-fall Satlantic MicroPro II multichannel UV/Visible spectroradiometer. This instrument has 14 upwelling radiance sensors and 14 downwelling irradiance sensors in wavelength bands ranging from 305 to 683 nm. The package also mounts a WetLabs ECO chlorophyll fluorometer puck, plus ancillary sensors including X-Y tilt, internal and external temperatures. The instrument is allowed to trail away behind the port-side stern, then free-falls to 150m and is hand-recovered. We are using the radiometric data to study the effects of CDOM on the underwater light environment, to validate satellite ocean radiance sensor data, and to develop new algorithms employing satellite and in situ optical sensor data to retrieve ocean properties such as CDOM light absorbance, chlorophyll concentration, and particulate backscattering.

On the core CTD/rosette we deploy a WetLabs UV fluorometer (Ex 370 nm, Em 460 nm), which stimulates and measures fluorescence of CDOM. We are evaluating the use of this instrument to supplement or enhance bottle CDOM measurements, as bottle samples often do not have the depth resolution needed to resolve the observed strong near-surface gradients in CDOM concentration, and on cruises such as this we are not able to sample CDOM on every station. Differences between the fluorescence and absorption profiles may reveal gradients in chemical composition of CDOM. Signal to noise ratios for this instrument remain low for the open ocean areas that we are studying.

(This fluorometer is typically ganged to a WetLabs C-star 660 nm 0.1m pathlength beam transmissometer belonging to Dr. Wilford Gardner, TAMU. The transmissometer is used to gauge particle load in the water column, which can be calibrated to produce estimates of particulate carbon. Decline of the particle load with depth can then be related to POC flux, another element of the carbon system. On P6 Leg 1, SIO's transmissometer was used, but will likely be switched out for Dr. Gardner's for Leg 2 of the transect.)

Bottle Samples

CDOM is at present quantified by its light absorption properties. We are collecting samples of seawater for absorption spectroscopy on one deep ocean cast each day. CDOM is typically quantified as the absorption coefficient at a particular wavelength or wavelength range (we are using 325 nm). We determine CDOM at sea by measuring absorption spectra (280-730 nm) of 0.2um filtrates using a liquid waveguide spectrophotometer with a 200cm cell. On previous CLIVAR cruises I8S and I9N, duplicate samples were collected at a rate of ca. 2 samples per cast. RMS differences in absorption coefficient at 325 nm between the duplicate samples were just over 0.003 m-1, which is ca. 4% of the average absorption coefficient at that wavelength. On P6 Leg 1, technical problems were encountered with components of the liquid waveguide spectrophotometer, precluding at-sea analysis of CDOM from bottle samples. Samples were therefore collected at a lower frequency (every other day) at 18 – 24 depths during P6 Leg 1 and stored at 4C on board for later on-shore spectroscopic analysis. Replacement components of the spectrophotometer system delivered for Leg 2 should allow us to resume on-board absorption measurements of CDOM from bottle samples.

We also concurrently collect samples for bacterial abundance at 24 depths once per day to compare the distributions to those of CDOM and DOC.

Because of the connections to light availability and remote sensing, we collect bottle samples in the top 200m for chlorophyll analysis in addition to surface samples (from the ship's uncontaminated seawater system) for chlorophyll, carotenoid, and mycosporine-like amino acid pigment analysis (HPLC) and particulate absorption (spectrophotometric). We are sporadically collecting large volume (ca. 1L) samples for CDOM characterization experiments back at UCSB, and occasionally collecting large volume (2L) samples for POC analysis to compare with transmissometer data. We have the cooperation of the Trace Metals group for the large-volume subsurface samples for CDOM characterization from their Go-Flo bottles. We are only analyzing the CDOM and chlorophyll a at sea and the rest of the samples we prepare and store for analysis on shore.

Flow-through Measurements of surface-ocean Apparent Optical Properties (AOPs)

P6 serves as the first test cruise for a new underway optical data acquisition system developed at UCSB. This system utilizes the uncontaminated ship's seawater supply and an array of instrumentation to continuously quantify the absorption and backscattering of light in the surface ocean along the transect. These data supplement our bottle measurements of optical properties, as well as underwater light profiles conducted along P6, and will be used in various bio-optical studies and in the validation/calibration of ocean color satellite data. In brief, the system consists of a vortex debubbler, 0.2um filter, several flow sensors, a WetLabs AC-S in situ spectrophotometer for determination of absorption and beam attenuation coefficients, a WetLabs ECO BB scattering meter for determination of the volume scattering function due to particles, and an SBE 45 MicroTSG thermosalinograph for conductivity/temperature measurements. The system is automated through Based-based software installed on a PC laptop. (Software records ship GPS feed.)

Aerosol Optical Depth Measurements

We have taken measurements with a Microtops II Sun photometer at various points along P6 Leg 1. This small, handheld instrument (with associated handheld GPS meter) is utilized on deck during sunlit hours when clear sky conditions (i.e., no cloud cover) permit. The instrument provides measurements of aerosol optical depth (amount of photons removed from a beam of sunlight due to aerosols in the atmosphere) and are used within NASA's AERONET Maritime Aerosol Network to supplement land-based observations and validate satellite and aerosol transport models. These data are periodically uploaded and found at

http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

1.22. DNA/RNA Report

CLIVAR P6 2009 Leg 1 Brisbane to Papeete

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Samples of 3 Liters of unfiltered sea water were taken from the shallowest depth, nominally 20m bottle 12, from the Trace Metal casts, collected in a 4L polycarbonate bottle. The sea water was filtered immediately through three 0.2 micron, 25mm Pall Supor PES filters held by Swinex filter holders, using peristaltic pump with Masterflex L/S 25 tubing at speed setting four. Filtration was run for 15 minutes, or until the water had been emptied and ~1L had been filtered through each filter. Overflow was collected for measuring filtered volumes. Immediately after filtration finished, filters were removed and placed 2ml microcentrifuge cryovials containing 0.5ml of DNA Lysis Buffer and 0.5ml of RNA Buffer (Qiagen RLT + betamercaptoethanol). A single DNA sample was used, while duplicate RNA samples were taken at each station. Sample were then immediately flash frozen in -80°C Absolute Ethanol, removed after flash freezing from the alcohol, and kept at -80°C for storage. Flow Cytometry samples for picoplankton enumeration were taken by fixing 2ml of sea water with 0.5ml (16% Aq.) methanol-free paraformaldehyde (0.4% v/v Final), fixed for one hour in the fridge at 4°C, followed by a flash freeze in -80°C alcohol, and samples were also kept at -80°C for storage.

DNA, RNA, and flow cytometry will all be analyzed back at University of Hawaii. The first order information from the DNA & RNA sampling will be concentration of particulate (> 0.2 micron) DNA & RNA with units:

[DNA] (microg/L)
[RNA] (microg/L)

Flow cytometric samples will provide enumeration of cyanobacteria with units:

[Prochlorococcus] (cells/L)
[Synechococcus] (cells/L)

1.23. Trace metal hydrographic casts P6

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Hydrographic sampling for the trace elements Al and Fe was conducted during the CLIVAR P6 cruise aboard the R. V. Melville. In total 60 stations were occupied at approximately 1˚ longitude spacing yielding a total of 709 subsamples. Data generated onboard were submitted to the shipboard data assembly system and each parameter on each subsample was assigned a quality flag.

Samples were collected using a specially designed rosette system which consists of 12 x12L GoFlo bottles mounted on a powder coated rosette frame. The package was equipped with a Sea-Bird SBE 911 ctd that also had an SBE 43 oxygen sensor and a Wet Labs fl1 fluorometer. The package was lowered using a Kevlar conducting cable and bottles were tripped at predetermined depths from the ship using a deck box (Measures et al., 2008).

As the TM rosette was coming aboard at the end of station 79, cast 2, the core of the Kevlar cable parted and the rosette fell ~ 4 ft to the deck. The sheath of the cable stretched but did not break. It seems as though the break point coincided with the maximum stress point on the cable as it comes around the top roller on the winch as the A frame moves to its vertical position. The bend on the cable at this point is the maximum and several times during this cruise the winch had jerked as the rosette was lifted on board, further stressing this point of the cable. The upper part of the frame was bent significantly by this drop, causing problems with bottle mounting and dismounting. The frame was partially bent back towards its initial shape in order to circumvent this problem. The ctd appeared to suffer no damage as a result of this drop. After the cable was reterminated the ctd and pylon were tested on the deck and all appeared to be working correctly. This first deployment after the retermination also showed no problems.

Sub samples were collected from the GO-FLO bottles in the TM van using previously documented procedures. Dissolved Al and Fe were determined on these water samples using Flow Injection Analysis (C. I. Measures, University of Hawaii). In addition samples were collected for shore based ICPMS determinations of dissolved and dissolvable Fe, Ni, Cu, Zn, Cd, and Pb by isotope dilution (W. M. Landing, FSU). Particulate samples were also collected for shore based determination of trace elements by EDXRF (Joe Resing, NOAA/PMEL). Aerosol samples were not collected during this cruise.

Appendix A

CLIVAR P06: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	ITS-90 Temperature Coefficients $corT = tp2*corP^2 + tp1*corP + t0$ tp2	tp1	t0	Conductivity Coefficients $corC = cp2*corP^2 + cp1*corP + c2*C^2 + c1*C + c0$ cp2	cp1	c2	c1	c0	
001/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006322	
002/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006310	
003/05	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006239	
003/06	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006212	
004/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006192	
005/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006164	
006/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006138	
007/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006109	
008/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.006079	
009/02	0	-3.7916e-07	0.000313	1.59638e-10	-1.11819e-06	0	7.77210e-05	0.001067	T2C2
010/01	0	-3.7916e-07	0.000313	1.59638e-10	-1.11819e-06	0	7.77210e-05	0.001137	T2C2
011/03	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005976	
012/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005943	
013/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005911	
014/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005883	
015/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005850	
016/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005826	
017/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005797	
018/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005768	
019/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005738	
020/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005720	
021/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005701	
022/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005681	
023/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005652	
024/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005631	
025/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005612	
026/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005589	
027/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005565	
028/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005549	
029/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005534	
030/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005513	
031/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005496	
032/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005478	
033/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005461	
034/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005446	
035/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005432	
036/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005408	
037/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005389	
038/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005375	
039/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005357	
040/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005338	
041/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005318	

	ITS-90 Temperature Coefficients			Conductivity Coefficients				
Sta/	corT = tp2∗corP^2 + tp1∗corP + t0			corC = cp2∗corP^2 + cp1∗corP + c2∗C^2 + c1∗C + c0				
Cast	tp2	tp1	t0	cp2	cp1	c2	c1	c0
042/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005302
043/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005289
044/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005273
045/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005254
046/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005239
047/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005226
048/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004910
049/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005144
050/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005135
051/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005127
052/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005117
053/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005105
054/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005092
055/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005081
056/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005070
057/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005059
058/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005043
059/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005029
060/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005017
061/03	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.005004
062/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004994
063/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004986
064/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004974
065/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004963
066/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004954
067/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004946
068/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004937
069/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004929
070/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004924
071/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004919
072/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004911
073/02	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004904
074/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004901
075/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004896
076/01	2.7410e-11	-2.4157e-07	0.000098	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004892
077/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004886
078/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004881
079/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004877
080/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004871
081/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004866
082/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004863
083/03	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004859
084/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004857
085/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004856
086/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004854

	ITS-90 Temperature Coefficients			Conductivity Coefficients					
Sta/	corT = tp2∗corP^2 + tp1∗corP + t0			corC = cp2∗corP^2 + cp1∗corP + c2∗C^2 + c1∗C + c0					
Cast	tp2	tp1	t0	cp2	cp1	c2	c1	c0	
087/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004853	
088/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004853	
089/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004853	
090/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004854	
091/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004855	
092/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004856	
093/02	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004857	
094/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004859	
095/03	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004863	
096/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004866	
097/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004887	
098/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004895	
099/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004905	
100/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004914	
101/01	2.7410e-11	-2.4157e-07	0.000399	1.85415e-10	-1.31127e-06	-5.44871e-06	4.30902e-04	-0.004924	
102/01	0	-3.7916e-07	0.000579	1.59638e-10	-1.11819e-06	0	7.77210e-05	0.005191	T2C2
103/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.014980	
104/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015250	
105/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015268	
106/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015286	
107/03	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015308	
108/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015325	
109/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015344	
110/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015368	
111/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015386	
112/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015407	
113/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015427	
114/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015447	
115/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015468	
116/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015485	
117/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015501	
118/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015521	
119/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015540	
120/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015557	
121/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015577	
122/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015593	
123/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015611	
124/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015631	
125/02	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015650	
126/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015667	
127/01	2.7410e-11	-2.4157e-07	0.000399	6.35162e-11	-3.60325e-07	-1.19181e-05	9.09133e-04	-0.015935	

Appendix B

Summary of CLIVAR P06 CTD Oxygen Time Constants

(time constants in seconds)

Pressure Hysteresis (τ_h)	Temperature Long(τ_{Tl})	Temperature Short(τ_{Ts})	Pressure Gradient (τ_p)	O_2 Gradient (τ_{og})	Velocity (τ_{dP})	Thermal Diffusion (τ_{dT})
300.0	400.0	2.0	0.50	8.00	0.00	400.0

CLIVAR P06: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 1.7.4.0)

Sta/ Cast	O_c Slope (c_1)	Offset (c_3)	P_h coeff (c_2)	T_l coeff (c_4)	T_s coeff (c_5)	P_l coeff (c_6)	$\frac{dO_c}{dt}$ coeff (c_7)	$\frac{dP}{dt}$ coeff (c_8)	T_{dT} coeff (c_9)
001/01	6.771e-04	-0.340	6.572	1.255e-02	-1.638e-02	-1.446e-03	-1.832e-03	0	-0.017980
002/01	2.393e-04	0.005	0.004	7.086e-06	3.062e-02	1.226e-03	1.992e-05	0	0.000060
003/05	5.343e-04	-0.375	1.078	1.590e-02	-2.352e-03	5.059e-05	5.782e-03	0	-0.021902
003/06	5.166e-04	-0.176	-0.003	-9.560e-04	5.091e-03	1.255e-04	4.523e-04	0	-0.001679
004/01	5.986e-04	-0.245	-0.043	3.347e-03	-4.466e-03	1.276e-04	-6.513e-03	0	0.015557
005/02	5.762e-04	-0.238	-0.071	-2.829e-03	3.989e-03	1.462e-04	5.465e-03	0	0.002440
006/01	5.396e-04	-0.225	-0.075	-5.768e-03	1.108e-02	1.745e-04	-2.149e-04	0	-0.005328
007/02	5.318e-04	-0.196	0.001	4.307e-03	-1.262e-03	1.328e-04	1.739e-03	0	0.004380
008/01	5.341e-04	-0.197	-0.043	1.806e-03	1.799e-03	1.446e-04	2.093e-03	0	0.004821
009/02	5.495e-04	-0.222	-0.047	-1.768e-03	5.572e-03	1.546e-04	1.417e-03	0	-0.000035
010/01	5.474e-04	-0.206	0.006	1.355e-03	8.955e-04	1.273e-04	3.362e-03	0	0.003346
011/03	5.542e-04	-0.219	-0.006	2.771e-04	2.339e-03	1.356e-04	-1.036e-03	0	0.003036
012/01	5.791e-04	-0.241	0.039	-2.505e-03	3.925e-03	1.199e-04	-8.166e-03	0	0.001959
013/01	5.638e-04	-0.222	0.043	-6.662e-04	2.473e-03	1.165e-04	-1.683e-03	0	0.003579
014/01	5.797e-04	-0.235	0.038	1.900e-03	-1.435e-03	1.164e-04	-2.289e-03	0	0.007798
015/02	5.581e-04	-0.212	0.021	2.511e-03	-6.810e-04	1.195e-04	-1.208e-02	0	0.007423
016/01	5.782e-04	-0.243	0.018	-1.491e-03	3.207e-03	1.290e-04	-4.595e-03	0	0.002324
017/01	5.481e-04	-0.206	-0.012	6.227e-04	2.268e-03	1.333e-04	-2.692e-03	0	0.004250
018/02	5.690e-04	-0.236	-0.034	-2.782e-03	5.326e-03	1.470e-04	-4.065e-03	0	0.001269
019/02	6.660e-04	-0.295	-0.004	-2.524e-03	-1.359e-03	1.043e-04	-5.298e-03	0	0.012363
020/01	6.892e-04	-0.284	-0.379	-6.538e-03	4.043e-04	1.778e-04	1.148e-04	0	0.016531
021/01	4.335e-04	-0.160	0.181	5.383e-03	7.091e-03	1.615e-04	2.918e-04	0	-0.012252
022/01	6.249e-04	-0.245	-0.080	-2.538e-03	-2.947e-05	1.178e-04	1.308e-03	0	0.012349
023/02	5.821e-04	-0.243	-0.052	-1.315e-03	2.481e-03	1.477e-04	1.536e-03	0	0.004536
024/01	6.477e-04	-0.267	-0.120	-2.905e-03	-8.330e-04	1.280e-04	-2.551e-05	0	0.013415
025/01	6.971e-04	-0.307	0.153	-1.406e-03	-4.589e-03	4.028e-05	-1.686e-03	0	0.014894
026/01	5.037e-04	-0.178	0.342	2.683e-03	3.090e-03	4.057e-05	-4.722e-03	0	-0.006950
027/02	5.304e-04	-0.193	0.086	-1.997e-03	5.633e-03	9.977e-05	4.199e-03	0	-0.004986
028/01	5.964e-04	-0.296	0.018	6.188e-03	-4.240e-03	2.069e-04	1.854e-03	0	0.014752
029/01	5.118e-04	-0.204	0.529	3.757e-03	2.194e-03	2.782e-05	3.045e-03	0	-0.008172
030/01	5.123e-04	-0.208	-0.087	2.976e-04	6.043e-03	2.077e-04	-2.581e-03	0	-0.001110
031/02	5.797e-04	-0.221	-0.048	-6.703e-03	7.247e-03	9.870e-05	9.677e-04	0	-0.002169
032/01	5.370e-04	-0.249	0.412	4.108e-03	1.651e-03	7.282e-05	2.246e-03	0	-0.007538
033/02	5.893e-04	-0.246	0.067	-4.441e-03	5.135e-03	9.739e-05	2.014e-03	0	0.000269
034/01	5.528e-04	-0.171	0.244	-1.183e-04	5.665e-04	1.369e-05	-7.685e-04	0	0.003037
035/01	5.684e-04	-0.240	-0.063	-1.829e-03	4.101e-03	1.624e-04	4.107e-04	0	0.001924

Sta/ Cast	O_c Slope (c_1)	Offset (c_3)	P_h coeff (c_2)	T_l coeff (c_4)	T_s coeff (c_5)	P_l coeff (c_6)	$\frac{dO_c}{dt}$ coeff (c_7)	$\frac{dP}{dt}$ coeff (c_8)	T_{dT} coeff (c_9)
036/01	5.247e-04	-0.211	-0.166	-2.201e-03	7.519e-03	2.065e-04	-1.222e-03	0	-0.002706
037/02	4.831e-04	-0.154	-0.084	1.264e-03	5.953e-03	1.574e-04	-3.899e-03	0	-0.002240
038/01	5.294e-04	-0.191	-0.042	7.579e-04	3.162e-03	1.412e-04	-1.226e-03	0	0.002517
039/01	5.018e-04	-0.189	-0.018	1.529e-03	5.246e-03	1.631e-04	4.628e-03	0	-0.005087
040/01	5.334e-04	-0.209	-0.055	-3.056e-03	7.793e-03	1.607e-04	-1.986e-03	0	-0.003123
041/02	5.028e-04	-0.190	-0.106	-8.431e-04	7.728e-03	1.892e-04	-2.328e-03	0	-0.003009
042/01	5.079e-04	-0.185	-0.005	5.869e-04	5.310e-03	1.575e-04	-1.797e-03	0	-0.001436
043/01	7.211e-04	-0.208	-0.593	-1.690e-02	5.214e-03	3.768e-05	3.138e-03	0	0.003011
044/02	5.296e-04	-0.195	0.015	-1.659e-03	6.058e-03	1.260e-04	2.546e-03	0	-0.002766
045/02	4.713e-04	-0.142	0.054	-1.918e-03	9.796e-03	1.154e-04	-8.087e-03	0	-0.010476
046/01	4.838e-04	-0.150	0.019	8.551e-04	6.065e-03	1.224e-04	-1.468e-03	0	-0.004589
047/01	5.596e-04	-0.201	-0.040	-5.346e-04	1.959e-03	1.221e-04	-3.411e-03	0	0.007690
048/01	5.766e-04	-0.250	-0.039	-4.717e-04	2.366e-03	1.586e-04	-4.640e-03	0	0.004514
049/02	5.796e-04	-0.243	-0.100	-2.451e-03	3.883e-03	1.634e-04	2.147e-03	0	0.003364
050/01	4.144e-04	-0.120	0.700	5.198e-03	8.687e-03	1.079e-04	-7.072e-03	0	-0.006420
051/02	5.025e-04	-0.177	-0.081	8.754e-05	6.398e-03	1.647e-04	-1.547e-03	0	-0.001849
052/01	5.285e-04	-0.194	-0.028	1.067e-03	3.071e-03	1.396e-04	7.572e-04	0	-0.000091
053/01	5.450e-04	-0.205	0.096	-2.732e-03	6.173e-03	9.650e-05	1.807e-03	0	-0.003505
054/01	4.165e-04	-0.175	0.137	1.019e-02	6.563e-03	2.454e-04	1.547e-03	0	-0.011625
055/02	4.985e-04	-0.187	-0.069	5.024e-04	6.630e-03	1.765e-04	9.660e-04	0	-0.006197
056/01	5.848e-04	-0.253	-0.033	-2.564e-03	4.584e-03	1.531e-04	-6.829e-04	0	0.002666
057/01	5.203e-04	-0.194	-0.107	1.142e-03	4.283e-03	1.722e-04	-3.701e-04	0	0.000406
058/01	5.443e-04	-0.220	-0.015	-4.823e-03	9.157e-03	1.478e-04	-5.426e-03	0	-0.006724
059/02	5.183e-04	-0.195	-0.100	-8.873e-04	6.520e-03	1.729e-04	-2.694e-03	0	-0.003829
060/01	5.748e-04	-0.220	0.086	2.037e-03	-1.246e-03	9.097e-05	1.867e-03	0	0.007627
061/03	5.329e-04	-0.188	0.011	1.129e-03	2.816e-03	1.181e-04	3.545e-03	0	0.002755
062/01	5.634e-04	-0.236	-0.044	-2.420e-03	5.108e-03	1.581e-04	-2.370e-03	0	-0.001118
063/01	5.115e-04	-0.182	-0.048	-3.638e-03	9.884e-03	1.473e-04	-6.443e-03	0	-0.006639
064/01	5.544e-04	-0.218	-0.004	1.664e-03	1.275e-03	1.337e-04	2.374e-03	0	0.003138
065/02	5.602e-04	-0.226	-0.010	-7.943e-04	3.787e-03	1.388e-04	-1.130e-03	0	0.002949
066/01	5.403e-04	-0.207	-0.006	-3.188e-03	7.151e-03	1.363e-04	-2.994e-03	0	-0.004003
067/01	5.428e-04	-0.219	-0.059	-3.713e-03	8.072e-03	1.635e-04	-2.810e-03	0	-0.004033
068/02	5.461e-04	-0.200	-0.030	1.529e-03	1.116e-03	1.302e-04	4.135e-03	0	0.003857
069/02	5.038e-04	-0.120	0.083	2.349e-04	3.045e-03	5.066e-05	-5.531e-03	0	0.000434
070/01	4.887e-04	-0.180	-0.127	-1.322e-03	1.007e-02	1.946e-04	2.441e-03	0	-0.009621
071/01	5.232e-04	-0.204	-0.068	-3.637e-03	1.013e-02	1.694e-04	-3.892e-03	0	-0.005840
072/02	5.371e-04	-0.210	-0.056	1.718e-03	2.101e-03	1.588e-04	5.132e-04	0	-0.000354
073/02	5.433e-04	-0.222	0.112	-2.035e-05	4.197e-03	1.181e-04	-3.718e-03	0	-0.004110
074/01	5.608e-04	-0.230	-0.092	-3.521e-03	6.666e-03	1.677e-04	-7.474e-04	0	0.000390
075/01	5.423e-04	-0.211	-0.031	1.478e-03	2.962e-03	1.481e-04	4.276e-03	0	0.003247
076/01	5.497e-04	-0.224	-0.049	-2.903e-03	6.637e-03	1.571e-04	-4.122e-03	0	-0.002975
077/02	5.683e-04	-0.231	-0.005	1.864e-03	-1.933e-04	1.359e-04	-2.179e-03	0	0.006127
078/01	5.671e-04	-0.233	-0.001	-2.803e-03	5.397e-03	1.366e-04	-3.239e-03	0	-0.000375
079/01	5.618e-04	-0.229	-0.020	-7.664e-03	1.048e-02	1.435e-04	2.146e-04	0	-0.006907
080/02	5.980e-04	-0.259	0.036	-5.766e-03	6.821e-03	1.225e-04	7.122e-04	0	-0.000626
081/02	5.750e-04	-0.234	0.002	-1.156e-03	2.484e-03	1.324e-04	-4.892e-03	0	0.003449
082/01	5.401e-04	-0.210	-0.062	-4.312e-03	9.326e-03	1.593e-04	1.785e-03	0	-0.004445
083/03	5.879e-04	-0.245	0.010	8.573e-04	5.943e-05	1.295e-04	4.032e-03	0	0.006495

Sta/ Cast	O_c Slope (c_1)	Offset (c_3)	P_h coeff (c_2)	T_l coeff (c_4)	T_s coeff (c_5)	P_l coeff (c_6)	$\frac{dO_c}{dt}$ coeff (c_7)	$\frac{dP}{dt}$ coeff (c_8)	T_{dT} coeff (c_9)
084/01	5.961e-04	-0.253	0.022	-5.364e-03	6.207e-03	1.262e-04	-2.825e-03	0	0.001549
085/01	5.603e-04	-0.226	-0.027	-3.198e-03	6.280e-03	1.464e-04	-5.020e-04	0	-0.002296
086/01	5.697e-04	-0.232	-0.027	-2.776e-04	2.401e-03	1.450e-04	1.710e-03	0	0.001946
087/02	5.260e-04	-0.194	-0.094	1.626e-03	3.373e-03	1.674e-04	2.864e-03	0	0.000132
088/01	5.428e-04	-0.207	-0.062	-1.164e-03	5.270e-03	1.559e-04	-1.709e-03	0	-0.000534
089/02	5.697e-04	-0.232	-0.022	-8.749e-04	3.493e-03	1.430e-04	1.218e-03	0	0.002283
090/01	5.837e-04	-0.240	0.001	1.178e-03	-1.329e-04	1.328e-04	-4.129e-03	0	0.006322
091/02	5.432e-04	-0.211	-0.078	-1.801e-03	6.043e-03	1.649e-04	2.204e-03	0	-0.002867
092/01	5.577e-04	-0.206	0.535	4.111e-04	1.821e-03	-2.826e-05	5.084e-03	0	-0.009790
093/02	5.648e-04	-0.227	-0.024	1.087e-03	1.516e-03	1.442e-04	-1.102e-03	0	0.004140
094/01	5.360e-04	-0.205	-0.072	-1.767e-03	6.743e-03	1.622e-04	-3.041e-03	0	-0.004599
095/03	5.286e-04	-0.200	-0.102	-2.241e-03	7.779e-03	1.736e-04	-3.756e-03	0	-0.004363
096/01	5.291e-04	-0.199	-0.134	-9.486e-03	1.613e-02	1.848e-04	1.438e-03	0	-0.008390
097/01	5.410e-04	-0.206	-0.084	-3.572e-03	7.643e-03	1.644e-04	-4.593e-04	0	-0.006570
098/01	5.580e-04	-0.218	-0.024	-2.196e-03	5.296e-03	1.420e-04	1.828e-03	0	-0.001373
099/01	5.347e-04	-0.204	-0.057	1.824e-03	2.962e-03	1.571e-04	1.176e-03	0	-0.001084
100/01	6.106e-04	-0.260	0.009	1.453e-03	-1.583e-03	1.269e-04	-4.741e-03	0	0.011887
101/01	5.831e-04	-0.239	0.015	2.761e-05	1.013e-03	1.272e-04	2.897e-03	0	0.003710
102/01	5.455e-04	-0.212	-0.054	1.313e-03	2.825e-03	1.556e-04	2.107e-03	0	0.000905
103/01	5.620e-04	-0.224	-0.041	-1.313e-03	3.874e-03	1.499e-04	2.528e-03	0	0.000097
104/02	7.039e-04	-0.342	0.173	-1.857e-03	-4.212e-03	6.495e-05	-6.167e-03	0	0.015876
105/02	5.740e-04	-0.234	-0.025	-1.810e-04	2.050e-03	1.435e-04	4.840e-03	0	0.002096
106/01	5.752e-04	-0.233	-0.010	1.400e-03	3.906e-04	1.369e-04	3.592e-03	0	0.004226
107/03	5.868e-04	-0.243	0.021	-6.658e-04	1.688e-03	1.260e-04	5.046e-03	0	0.004433
108/01	5.514e-04	-0.213	-0.030	-3.510e-03	7.034e-03	1.445e-04	3.859e-03	0	-0.003824
109/01	5.141e-04	-0.187	-0.109	-1.539e-03	7.815e-03	1.750e-04	6.194e-03	0	-0.008302
110/01	5.264e-04	-0.195	-0.114	-7.163e-04	5.763e-03	1.747e-04	1.365e-03	0	-0.005088
111/01	5.521e-04	-0.214	-0.018	3.154e-04	2.980e-03	1.407e-04	4.419e-04	0	0.000444
112/02	5.790e-04	-0.241	-0.019	-1.722e-03	3.473e-03	1.431e-04	-1.035e-03	0	0.002469
113/02	5.824e-04	-0.240	-0.034	-5.187e-04	1.982e-03	1.461e-04	2.409e-03	0	0.004569
114/01	5.564e-04	-0.220	-0.051	1.541e-04	2.944e-03	1.535e-04	4.450e-03	0	0.000047
115/02	5.581e-04	-0.223	-0.038	-9.259e-04	4.044e-03	1.506e-04	3.764e-03	0	-0.000870
116/01	5.743e-04	-0.232	-0.042	-1.177e-04	1.892e-03	1.479e-04	4.067e-04	0	0.004494
117/01	5.667e-04	-0.223	-0.015	6.447e-05	2.042e-03	1.373e-04	-9.259e-04	0	0.002980
118/01	5.080e-04	-0.185	-0.143	1.605e-03	4.847e-03	1.888e-04	-2.259e-03	0	-0.004807
119/02	5.528e-04	-0.217	-0.060	5.024e-04	2.962e-03	1.573e-04	1.691e-03	0	0.000792
120/01	5.692e-04	-0.233	-0.048	-8.751e-04	3.185e-03	1.539e-04	1.327e-03	0	0.001682
121/02	5.115e-04	-0.184	-0.089	1.337e-03	4.911e-03	1.675e-04	6.961e-03	0	-0.005863
122/01	5.119e-04	-0.184	-0.134	1.899e-03	3.938e-03	1.822e-04	5.576e-03	0	-0.006464
123/01	5.498e-04	-0.212	-0.055	1.153e-03	2.186e-03	1.537e-04	4.203e-03	0	0.000438
124/01	5.603e-04	-0.224	-0.037	-1.655e-04	3.145e-03	1.493e-04	2.361e-03	0	0.000511
125/02	5.456e-04	-0.210	-0.130	1.634e-03	2.173e-03	1.807e-04	2.753e-03	0	0.003635
126/01	6.240e-04	-0.275	0.025	4.551e-04	-1.498e-03	1.237e-04	3.599e-03	0	0.010325
127/01	5.515e-04	-0.217	-0.072	-5.750e-05	3.664e-03	1.621e-04	2.956e-03	0	-0.001678

Appendix C

CLIVAR P06: Bottle Quality Comments

Comments from the Sample Logs and the results of STS/ODF's data investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, Unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, and Phosphate. The sample number is the cast number times 100 plus the bottle number. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and re-reading of charts (i.e. nutrients).

Station /Cast	Sample No.	Quality Property	Code	Comment
1/1	101	reft	3	SBE35T +0.045/+0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	102	reft	3	SBE35T -0.015/-0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	103	reft	3	SBE35T +0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	104	reft	3	SBE35T +0.045/+0.050 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	106	reft	3	SBE35T -0.105/-0.115 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	125	reft	3	SBE35T -0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	126	reft	3	SBE35T -0.035/-0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	128	reft	3	SBE35T -0.070/-0.065 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	129	reft	3	SBE35T +0.070/+0.080 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
1/1	130	reft	3	SBE35T +0.040/+0.050 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
2/1	101	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	101	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	101	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	101	sio3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	102	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	102	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	102	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	102	sio3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	103	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	103	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	103	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	103	sio3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	104	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	104	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	104	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	104	sio3	2	nutrient samples left lid-down and out on deck for several hours.

Station /Cast	Sample No.	Property	Quality Code	Comment
2/1	105	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	105	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	105	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	105	sio3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	106	no2	2	nutrient samples left lid-down and out on deck for several hours.
2/1	106	no3	2	nutrient samples left lid-down and out on deck for several hours.
2/1	106	po4	2	nutrient samples left lid-down and out on deck for several hours.
2/1	106	sio3	2	nutrient samples left lid-down and out on deck for several hours.
3/5	501	bottle	3	Leak: open valve, niskin leaking from bottom.
3/6	614	o2	2	O2 analyst: Further titration 13 ABORTED. O2 bottle value matches CTDO2, and trends in adjacent profiles.
3/6	619	o2	3	O2 analyst: Further titration 15 ABORTED, 38 ABORT, last bit of titration, previous addition was 0.524ml, total should be 0.5278.
3/6	620	salt	2	Salt Analyst: Thimble came out with cap.
3/6	622	o2	2	O2 analyst: Further titration 15 ABORT. O2 bottle value matches CTDO2, and trends in adjacent profiles.
3/6	625	salt	2	Bottle salt value +0.08 vs. CTDS1, code questionable.
3/6	626	CTDT2	3	CTDT2 -0.025 vs CTDT1/SBE35T; code CTDT2 questionable.
3/6	628	o2	2	O2 bottle value -14 umol/kg from downcast profile, questionable.
3/6	632	reft	3	SBE35T +0.015/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
3/6	633	reft	3	SBE35T +0.02 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
3/6	634	reft	3	SBE35T +0.045 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
4/1	102	o2	3	Sample is lower than profile and adjacent casts.
4/1	106	o2	2	O2 analyst: 6, out of sequence. O2 bottle value matches CTDO2, and trends in adjacent profiles.
4/1	122	sio3	3	High compared to profile and adjoining stations. No corresponding feature in other nutrient or oxy parameters. No analytical errors noted.
4/1	130	reft	3	SBE35T +0.060/+0.055 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
4/1	132	o2	4	"floating crap in sample - possible bad measurement."
5/2	201	o2	2	O2 analyst: Further titration 4 ABORTED. O2 bottle value matches CTDO2, and trends in adjacent profiles.
5/2	204	salt	2	Salt Analyst: BTL4 Thimble came out with cap
5/2	208	salt	3	Salt Analyst: BTL4 Thimble came out with cap. Bottle Salt +0.03 vs. CTDS1/S2, code questionable.
5/2	208	sio3	3	High compared to profile and adjoining stations. No corresponding feature in other nutrient or oxy parameters. No analytical errors noted.
5/2	215	salt	2	Salt Analyst: BTL4 Thimble came out with cap
5/2	231	salt	2	Salt Analyst: BTL4 Thimble came out with cap
6/1	102	reft	3	SBE35T -0.002 vs CTDT1/CTDT2 (deep); unstable SBE35T reading for deep, code questionable.
6/1	105	bottle	2	Pressure release tab not tight on niskin.
6/1	105	o2	2	O2 bottle value +1.80umol/kg from profile, high for deep sample.
6/1	119	o2	2	O2 analyst: High titration end point ˜0.0007. O2 bottle value matches CTDO2, and trends in adjacent profiles.
6/1	130	bottle	2	Bubbles coming from niskin.
6/1	130	o2	3	Sample value +15.40umol/kg from upcast profile and high for previous cast.
6/1	131	o2	3	Sample value +12.19umol/kg from upcast profile and high for previous cast.

Station /Cast	Sample No.	Quality Property	Code	Comment
6/1	132	o2	3	Sample value -16.28umol/kg from upcast profile and high for previous cast.
6/1	134	o2	2	O2 analyst: High titration end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
6/1	135	CTDT2	3	CTDT2 +0.060/+0.165 vs CTDT1/SBE35T; code CTDT2 questionable.
6/1	135	reft	3	SBE35T -0.105/-0.165 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
7/2	201	no3	4	auto-analyzer error. code bad all bottles.
7/2	201	o2	3	Bottle o2 value seems high compared to sample 102 on station 8 at same pot.temp, and appears to distort CTDO fit. Used 8-102 for CTDO fit at bottom on station 7. Code bottle o2 questionable.
7/2	201	po4	4	auto-analyzer error. code bad all bottles.
7/2	201	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	202	no3	4	auto-analyzer error. code bad all bottles.
7/2	202	po4	4	auto-analyzer error. code bad all bottles.
7/2	202	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	203	no3	4	auto-analyzer error. code bad all bottles.
7/2	203	po4	4	auto-analyzer error. code bad all bottles.
7/2	203	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	204	no3	4	auto-analyzer error. code bad all bottles.
7/2	204	po4	4	auto-analyzer error. code bad all bottles.
7/2	204	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	205	no3	4	auto-analyzer error. code bad all bottles.
7/2	205	po4	4	auto-analyzer error. code bad all bottles.
7/2	205	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	206	no3	4	auto-analyzer error. code bad all bottles.
7/2	206	po4	4	auto-analyzer error. code bad all bottles.
7/2	206	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	207	no3	4	auto-analyzer error. code bad all bottles.
7/2	207	po4	4	auto-analyzer error. code bad all bottles.
7/2	207	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.

Station /Cast	Sample No.	Quality Property	Code	Comment
7/2	208	no3	4	auto-analyzer error. code bad all bottles.
7/2	208	po4	4	auto-analyzer error. code bad all bottles.
7/2	208	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	209	no3	4	auto-analyzer error. code bad all bottles.
7/2	209	po4	4	auto-analyzer error. code bad all bottles.
7/2	209	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	210	no3	4	auto-analyzer error. code bad all bottles.
7/2	210	po4	4	auto-analyzer error. code bad all bottles.
7/2	210	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	211	no3	4	auto-analyzer error. code bad all bottles.
7/2	211	po4	4	auto-analyzer error. code bad all bottles.
7/2	211	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	212	bottle	2	Package moved during trip.
7/2	212	no3	4	auto-analyzer error. code bad all bottles.
7/2	212	o2	4	O2 analyst: Sample was overtitrated and backtitrated. 0.4137 overtitrated by mistake, endpoint was ˜0.4141. O2 bottle value -22 umol/kg vs CTDO2. See bottle comment.
7/2	212	po4	4	auto-analyzer error. code bad all bottles.
7/2	212	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	213	no3	4	auto-analyzer error. code bad all bottles.
7/2	213	po4	4	auto-analyzer error. code bad all bottles.
7/2	213	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	214	no3	4	auto-analyzer error. code bad all bottles.
7/2	214	po4	4	auto-analyzer error. code bad all bottles.
7/2	214	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	215	no3	4	auto-analyzer error. code bad all bottles.
7/2	215	o2	2	O2 analyst: Stopper 837 in flask 1304 (also see bottle 16). O2 bottle value matches CTDO2, and trends in adjacent profiles.
7/2	215	po4	4	auto-analyzer error. code bad all bottles.

Station /Cast	Sample No.	Quality Property	Code	Comment
7/2	215	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	216	no3	4	auto-analyzer error. code bad all bottles.
7/2	216	o2	2	O2 analyst: Stopper 1304 in Flask 837 (see bottle 15). O2 bottle value matches CTDO2, and trends in adjacent profiles.
7/2	216	po4	4	auto-analyzer error. code bad all bottles.
7/2	216	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	217	no3	4	auto-analyzer error. code bad all bottles.
7/2	217	po4	4	auto-analyzer error. code bad all bottles.
7/2	217	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	218	no3	4	auto-analyzer error. code bad all bottles.
7/2	218	po4	4	auto-analyzer error. code bad all bottles.
7/2	218	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	219	no3	4	auto-analyzer error. code bad all bottles.
7/2	219	po4	4	auto-analyzer error. code bad all bottles.
7/2	219	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	220	no3	4	auto-analyzer error. code bad all bottles.
7/2	220	po4	4	auto-analyzer error. code bad all bottles.
7/2	220	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	221	no3	4	auto-analyzer error. code bad all bottles.
7/2	221	po4	4	auto-analyzer error. code bad all bottles.
7/2	221	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	222	no3	4	auto-analyzer error. code bad all bottles.
7/2	222	po4	4	auto-analyzer error. code bad all bottles.
7/2	222	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	223	no3	4	auto-analyzer error. code bad all bottles.
7/2	223	po4	4	auto-analyzer error. code bad all bottles.

Station /Cast	Sample No.	Quality Property	Code	Comment
7/2	223	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	224	no3	4	auto-analyzer error. code bad all bottles.
7/2	224	po4	4	auto-analyzer error. code bad all bottles.
7/2	224	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	225	no3	4	auto-analyzer error. code bad all bottles.
7/2	225	po4	4	auto-analyzer error. code bad all bottles.
7/2	225	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	226	no3	4	auto-analyzer error. code bad all bottles.
7/2	226	po4	4	auto-analyzer error. code bad all bottles.
7/2	226	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	227	no3	4	auto-analyzer error. code bad all bottles.
7/2	227	po4	4	auto-analyzer error. code bad all bottles.
7/2	227	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	228	no3	4	auto-analyzer error. code bad all bottles.
7/2	228	o2	4	O2 analyst: Sample was overtitrated and backtitrated. O2 bottle value -21 umol/kg vs CTDO2. See bottle comment.
7/2	228	po4	4	auto-analyzer error. code bad all bottles.
7/2	228	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	229	no3	4	auto-analyzer error. code bad all bottles.
7/2	229	po4	4	auto-analyzer error. code bad all bottles.
7/2	229	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	230	no3	4	auto-analyzer error. code bad all bottles.
7/2	230	po4	4	auto-analyzer error. code bad all bottles.
7/2	230	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	231	no3	4	auto-analyzer error. code bad all bottles.
7/2	231	po4	4	auto-analyzer error. code bad all bottles.

Station /Cast	Sample No.	Quality Property	Code	Comment
7/2	231	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	232	no3	4	auto-analyzer error. code bad all bottles.
7/2	232	po4	4	auto-analyzer error. code bad all bottles.
7/2	232	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	233	no3	4	auto-analyzer error. code bad all bottles.
7/2	233	po4	4	auto-analyzer error. code bad all bottles.
7/2	233	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	234	no3	4	auto-analyzer error. code bad all bottles.
7/2	234	po4	4	auto-analyzer error. code bad all bottles.
7/2	234	reft	3	SBE35T +0.015/+0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
7/2	234	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	235	no3	4	auto-analyzer error. code bad all bottles.
7/2	235	po4	4	auto-analyzer error. code bad all bottles.
7/2	235	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
7/2	236	no3	4	auto-analyzer error. code bad all bottles.
7/2	236	po4	4	auto-analyzer error. code bad all bottles.
7/2	236	reft	3	SBE35T +0.040/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
7/2	236	salt	2	Salt Analyst: "probably a bad standard bottle" at start; deep salts low by 0.007 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 low, probably a small drift during run. Salts within acceptable ranges, code acceptable.
8/1	106	salt	3	Salt +0.005 vs. CTDS1/S2, deep bottle; code questionable.
8/1	124	reft	3	SBE35T +0.020/+0.020 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
8/1	134	reft	3	SBE35T -0.020/-0.020 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
9/2	223	o2	2	O2 analyst: "Funky looking curve - data looks bad." O2 bottle value matches CTDO2, and trends in adjacent profiles
9/2	229	reft	3	SBE35T +0.015/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
9/2	235	CTDOXY	4	primary pump apparently blocked until 32db downcast, code CTDO bad.
9/2	235	o2	2	O2 bottle value +87 umol/kg vs down cast CTDO, however it matches upcast CTDO profile.

Station /Cast	Sample No.	Quality Property	Code	Comment
9/2	235	reft	3	SBE35T -0.030/-0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
9/2	236	CTDOXY	4	primary pump apparently blocked until 32db downcast, code CTDO bad.
10/1	102	salt	3	Salt +0.003/+0.003 vs. CTDS1/CTDS2 questionable for 4420db.
10/1	105	o2	2	O2 analyst: Titration error "4 ABORT". O2 bottle value matches CTDO22 and trend in adjacent profiles.
10/1	109	o2	3	O2 bottle sample +3 umol/kg from profile, questionable for 2440db.
10/1	131	o2	2	O2 bottle sample -29 umol/kg vs. down cast profile, however matched upcast CTDO data.
10/1	132	o2	2	O2 bottle sample -18 umol/kg vs. down cast profile, however matched upcast CTDO data.
10/1	134	reft	3	SBE35T -0.020/-0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
10/1	135	CTDOXY	4	primary pump apparently blocked until 32db downcast, code CTDO bad.
10/1	135	o2	2	O2 bottle sample +37 umol/kg vs. down cast profile, however matched upcast CTDO data.
10/1	136	CTDOXY	4	primary pump apparently blocked until 32db downcast, code CTDO bad.
10/1	136	o2	2	O2 bottle sample +40 umol/kg vs. down cast profile, however matched upcast CTDO data. o2 analyst: High titration end point by about .0008.
11/3	318	o2	5	O2 analyst: "sample lost (spilled)". Code sample lost.
11/3	335	reft	3	SBE35T +0.03 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
12/1	129	o2	2	O2 bottle value +13 umol/kg vs CTDO down cast profile, however matches upcast CTDO data.
12/1	131	o2	2	O2 bottle value +18 umol/kg vs CTDO down cast profile, however matches upcast CTDO data.
12/1	132	salt	3	Salt -0.016/-0.018 vs. CTDS1/CTDS2, questionable for 116db.
13/1	123	reft	3	SBE35T +0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
13/1	131	o2	2	O2 bottle value -13 umol/kg vs. down cast profile, however matches upcast CTDO data.
13/1	133	o2	2	O2 bottle value -13 umol/kg vs. down cast profile, however matches upcast CTDO data.
13/1	134	reft	3	SBE35T -0.020/-0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
14/1	124	o2	3	O2 bottle value +5 umol/kg vs profile and adjacent casts.
14/1	125	reft	3	SBE35T +0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
14/1	130	o2	2	O2 bottle value -14umol vs down cast profile, however matches upcast CTDO profile.
14/1	135	reft	3	SBE35T -0.010/-0.020 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
15/2	201	o2	4	O2 analyst: "stir bar set too slow, o2 sample lost", O2 is 7 umol/kg high vs CTDO, Code o2 bad.
15/2	209	salt	3	Salt -0.0035/-0.0035 vs CTDS1/CTDS2, questionable for 2612db.
15/2	211	salt	3	Salt -0.0025/-0.0035 vs CTDS1/CTDS2, questionable for 2100db.
15/2	231	o2	2	O2 bottle value -12 umol/kg from down cast profile, however matches upcast profile.
15/2	232	o2	2	O2 bottle value -14 umol/kg from down cast profile, however matches upcast profile.

Station /Cast	Sample No.	Quality Property	Code	Comment
15/2	233	o2	2	O2 bottle value -15 umol/kg from down cast profile, however matches upcast profile.
15/2	234	o2	2	O2 bottle value -29 umol/kg from down cast profile, however matches upcast profile.
16/1	114	bottle	4	Btl 14 failed to trip because lanyard not strung through lanyard guide.
16/1	118	bottle	2	Vent found open on Niskin.
16/1	120	o2	4	O2 analyst: "stir bar set too low, o2 sample lost". O2 is 25 umol/kg high vs CTDO. Code O2 bad.
16/1	122	bottle	2	Vent found open on Niskin.
16/1	131	o2	2	O2 bottle value -12 umol/kg vs downcast profile, however matches up cast.
16/1	131	salt	3	Bottle salt value +0.010 vs CTDS1/CTDS2, code questionable.
16/1	135	reft	3	SBE35T -0.045 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
17/1	105	salt	2	Salt Analyst: BTL5 thimble came out with cap classic contamination reading pattern.
17/1	129	o2	2	O2 bottle value +10 umol/kg with down cast, however matches up cast.
17/1	130	o2	2	O2 bottle value +10 umol/kg with down cast, however matches up cast.
17/1	133	o2	2	O2 bottle value +15 umol/kg with down cast, however matches up cast.
18/2	211	bottle	9	Btl 11 Spigot sheared off on deployment, not used.
18/2	227	reft	3	SBE35T -0.02 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
18/2	228	salt	2	Salt analyst: thimble popped off with cap #29.
18/2	233	o2	2	O2 bottle value +40.70 umol/kg vs. down cast profile, however matches up cast.
19/2	202	po4	4	Bottle value offset with profile. Peak read error. Code bad.
19/2	202	salt	2	Salt analyst: thimble popped off with cap #16.
19/2	224	bottle	2	Bottle tripped on-the-fly.
19/2	224	o2	2	O2 bottle value -12 umol/kg vs. down cast profile, however matches up cast profile.
19/2	227	reft	3	SBE35T -0.01/-0.02 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
20/1	102	salt	3	Salt bottle value +0.007/0.008 vs. CTDS1/CTDS2, questionable for 1700db.
20/1	104	salt	2	Salt analyst: thimble popped off cap #4.
20/1	113	o2	3	O2 bottle sample +9 umol/kg vs up & down cast profiles.
20/1	117	salt	2	Salt analyst: thimble popped off cap #18.
20/1	122	o2	2	O2 bottle value +16.87 umol/kg vs down cast profile, however matches upcast profile.
21/1	107	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value -2 umol/kg vs CTDO2, with in acceptable limits. Matches trends in adjacent profiles.
21/1	109	o2	4	Code 5 No Reagents added to sample!
21/1	119	o2	2	O2 bottle value +11 umol/kg vs. down cast profile, however matches upcast profile.
22/1	122	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value -11umol/kg vs. CTDO2, however value matches trends in adjacent profiles and feature in nutrient profiles at ˜250db.
23/2	202	salt	2	Salt analyst: thimble came off with cap #2.
23/2	204	salt	3	Salt analyst: thimble came off with cap #4. Bottle value +0.005 vs. CTDS1/CTDS2 (deep), code questionable.
23/2	215	o2	4	ABORT --- sampled but not analyzed.
23/2	217	salt	2	Salt analyst: thimble came off with cap#17.
24/1	109	salt	2	Salt analyst: thimble came off with cap #9.

Station /Cast	Sample No.	Quality Property	Code	Comment
24/1	116	salt	2	Salt analyst: thimble came off with cap #16.
25/1	101	reft	3	SBE35T -0.003 vs CTDT1 (deep); unstable SBE35T reading for deep, code questionable.
25/1	111	salt	3	Salt bottle value +0.006/0.006 vs. CTDS1/CTDS2, questionable for 1200db.
25/1	121	o2	2	O2 analyst: Further end point titration 13 ABORTED. O2 bottle value matches CTDO2, adjacent profile trend and feature in nutrient profiles.
25/1	122	o2	2	O2 analyst: Further end point titration 47 ABORTED. O2 bottle value +3 umol/kg vs. CTDO2 with in acceptable limits for 350db. Bottle value matches adjacent profile trend and feature in nutrient profiles.
25/1	129	salt	2	Salt analyst: thimble came off with cap #29.
25/1	131	o2	2	O2 analyst: Further end point titration 72 ABORTED. O2 bottle value matches CTDO2 and adjacent profile trend.
26/1	101	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	102	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	103	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	104	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	105	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	106	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	107	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	108	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	109	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	110	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	111	salt	2	Salt analyst BTL10 Thimble came out with cap.
26/1	112	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	113	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	114	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	115	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	116	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	117	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	118	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	119	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	120	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.

Station /Cast	Sample No.	Quality Property	Code	Comment
26/1	121	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	122	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
26/1	123	salt	2	Used Standard Batch P149 at start of Autosal run, P151 at end. Adjusted end wormley value by P151-P149 difference and updated salts.
27/2	201	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	202	salt	3	Salt bottle value +0.005/0.005 vs CTDS1/CTDS2, questionable for 1500db
27/2	203	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	204	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	205	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	206	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	207	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	208	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	209	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	210	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	211	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	212	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	213	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	214	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	215	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	216	bottle	4	High o2 draw temperature reading on niskin 16; bottle warm to touch, closed late/shallower than intended.

Station /Cast	Sample No.	Quality Property	Code	Comment
27/2	216	no2	4	Nutrients from shallower level than intended trip, bottle mis-tripped. code bad.
27/2	216	no3	4	Nutrients from shallower level than intended trip, bottle mis-tripped. code bad.
27/2	216	o2	4	O2 value 25 umol/kg high vs CTDO, bottle tripped shallower than intended, code bad.
27/2	216	po4	4	Nutrients from shallower level than intended trip, bottle mis-tripped. code bad.
27/2	216	salt	4	Salt bottle value +0.09/0.09 vs CTDS1/CTDS2, bottle mis-trip. code bad.
27/2	216	sio3	4	Nutrients from shallower level than intended trip, bottle mis-tripped. code bad.
27/2	217	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	218	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	219	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	220	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	221	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	222	reft	3	SBE35T +0.07/+0.08 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
27/2	222	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	223	salt	2	Used Standard Batch P151 for Autosal run, but adjusted standard dial for P149 K15/CRatio value. Added (P151-P149) CRatio difference to all Cond.Ratios for run, including wormleys, and updated salts.
27/2	224	salt	3	Bottle salt value +0.010 vs CTDS1/CTDS2, code questionable.
28/1	117	reft	3	SBE35T +0.035/+0.045 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
29/1	119	o2	2	O2 analyst: extreme stepping....really high voltage value.
30/1	101	o2	2	O2 analyst: stopper 1384 in flask 1435. O2 bottle value matches CTDO2, and trends in adjacent profiles.
30/1	103	o2	2	O2 analyst: high titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles.
30/1	104	o2	2	O2 analyst: high titration end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
30/1	105	salt	2	Salt analyst: thimble came off with cap#5.
30/1	112	reft	3	SBE35T +0.045 vs CTDT1; unstable SBE35T reading, code questionable.
30/1	115	o2	2	Bottle O2 value higher than profile and adjacent cast, questionable.
30/1	116	reft	3	SBE35T +0.015/+0.010 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
30/1	121	reft	3	SBE35T +0.020/+0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
30/1	121	salt	2	Salt analyst: thimble came off with cap #21.
31/2	206	o2	2	Bottle O2 value high for profile and adjacent casts.
31/2	208	o2	2	O2 analyst: High titration end point ˜0.005. O2 bottle value matches CTDO2, and trends in adjacent profiles.
31/2	210	salt	2	Salt analyst: BTL10 Thimble came out with cap.
31/2	214	o2	2	O2 analyst: High titration end point ˜0.003. WRONG STOPPER 1129 in 1413 see #15. O2 bottle value -2umol/kg vs CTDO2, within acceptable limits, however matches profile value.
31/2	215	o2	3	O2 analyst: WRONG STOPPER 1413 in 1129 see #14. O2 bottle value +7umol/kg vs CTDO2.
32/1	102	salt	2	BTL2 Thimble loose in bottle.
32/1	104	salt	2	BTL4 Thimble came out with cap.
32/1	114	o2	2	O2 analyst: High titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles.
32/1	117	salt	2	BTL17 Thimble came out with cap.
33/2	210	salt	2	Salt analyst: Thimble came off with cap#10.
34/1	101	o2	2	O2 analyst: Flask had the wrong stopper. O2 bottle value matches CTDO2, and trends in adjacent profiles.
34/1	102	o2	2	O2 analyst: Flask had the wrong stopper. O2 bottle value matches CTDO2, and trends in adjacent profiles.
34/1	102	salt	3	Salt bottle value +0.04/0.04 vs CTDS1/CTDS2, questionable for 1800db.
34/1	116	bottle	2	Vent loose on niskin 16.
34/1	117	o2	2	O2 analyst: Flask had the wrong stopper. O2 bottle value matches CTDO2, and trends in adjacent profiles.
34/1	118	o2	2	O2 analyst: First titration aborted. Titration tip not in flask. O2 bottle value matches CTDO2, and trends in adjacent profiles.
34/1	125	CTDT2	3	CTDT2 +0.020/+0.025 vs CTDT1/SBE35T; code CTDT2 questionable.
35/1	105	o2	2	Bottle O2 value low for profile and adjacent casts.
35/1	108	salt	2	Salt analyst: thimble came off with cap #8.
35/1	110	o2	2	O2 analyst: Sample was overtitrated and backtitrated. First titration end point 0.4307, second end point ˜0.0005, final end point ˜0.0001. O2 bottle value matches CTDO2, and trends in adjacent profiles.
35/1	112	salt	2	Salt analyst: thimble came off with cap #12.
35/1	113	sio3	4	SiO3 peak read error. Value low. Code bad.
35/1	116	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High end point titration ˜0.003ml.
35/1	116	salt	2	Salt analyst: thimble came off with cap #16.
35/1	117	bottle	2	Spigot open on niskin 17.
35/1	119	reft	3	SBE35T +0.060/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
35/1	122	reft	3	SBE35T +0.010/+0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
35/1	126	o2	2	O2 analyst: 1 ml standard added. Sample was overtitrated and backtitrated. 0.05207ml + 0.5452ml (Thio over titration) - 0.055678ml (IO standard titration). O2 bottle value -3umol/kg vs CTDO2 however matches profile and trends in adjacent profiles.
35/1	130	reft	3	SBE35T +0.085/+0.080 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
35/1	131	bottle	2	Bubbles in pH sample. Possible vent leak on niskin 31.
36/1	101	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.

Station /Cast	Sample No.	Quality Property	Code	Comment
36/1	101	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	102	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	102	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	103	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	103	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	104	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	104	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	105	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	105	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	106	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	106	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	107	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	107	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	108	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	108	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	109	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	109	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	110	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	110	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	111	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	111	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	112	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	112	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	113	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	113	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.

Station /Cast	Sample No.	Quality Property	Code	Comment
36/1	114	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	114	o2	2	O2 analyst: Sample was overtitrated and backtitrated. At 0.6624 added 4ml standard to get -color-, subtract 0.4 x IO3 titer from 0.71560. O2 bottle value 2 umol/kg vs CTDO2i, within acceptable limits. Value matches adjacent profile.
36/1	114	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	115	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	115	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	116	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	116	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	116	salt	2	Salt bottle value +0.006/0.007 (PSU) vs CTDS1/CTDS2 at 842.5db, questionable.
36/1	117	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	117	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	118	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	118	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	119	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	119	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	120	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	120	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	121	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	121	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	122	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	122	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	123	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	123	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	124	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	124	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	124	salt	2	Salt analyst: BTL24 Thimble came out with cap.

Station /Cast	Sample No.	Quality Property	Code	Comment
36/1	125	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	125	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	126	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	126	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	127	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	127	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	128	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	128	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	129	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	129	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	130	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	130	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	131	no3	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
36/1	131	po4	2	Profile low compared to adjoining stations. similar trend in po4. no analytical errors noted.
37/2	202	bottle	2	Cracked spigot.
37/2	205	salt	3	Salt bottle value +0.003/0.004 vs CTDS1/CTDS2 (PSU) at ˜2200db.
37/2	218	bottle	4	Nutrients and oxygen high, salinity low; bottle apparently closed 50+db deeper. Code as mis-trip.
37/2	218	no2	4	Nutrients high, apparent mis-trip. Code bad.
37/2	218	no3	4	Nutrients high, apparent mis-trip. Code bad.
37/2	218	o2	4	Oxygen high, apparent mis-trip. Code bad.
37/2	218	po4	4	Nutrients high, apparent mis-trip. Code bad.
37/2	218	salt	4	Apparent mis-trip. Salt bottle value -0.13/0.13 vs CTDS1/CTDS2 (PSU) at 568db.
37/2	218	sio3	4	Nutrients high, apparent mis-trip. Code bad.
37/2	221	reft	3	SBE35T -0.025/-0.020 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
37/2	222	reft	3	SBE35T +0.035 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
37/2	229	o2	4	O2 analyst: sulfuric acid was added late, sample lost. O2 value ˜3.5ml/l high, code bad.
37/2	229	reft	3	SBE35T -0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
38/1	102	salt	2	Salt analyst: sample 97 substandard A09 337.
38/1	118	bottle	4	Salt high, nutrients low, oxygen ok (similar at both depths); bottle apparently closed ˜300db shallower. Code as mis-trip.
38/1	118	no2	4	Nutrients low, apparent mis-trip. Code nutrients bad.

Station /Cast	Sample No.	Quality Property	Code	Comment
38/1	118	no3	4	Nutrients low, apparent mis-trip. Code nutrients bad.
38/1	118	o2	4	Other parameters show this bottle mis-tripped ˜300db shallower; o2 similar at both pressures. Code oxygen bad.
38/1	118	po4	4	Nutrients low, apparent mis-trip. Code nutrients bad.
38/1	118	salt	4	Salt bottle value +0.632/+0.633 vs CTDS1/CTDS2 (PSU) at ˜600 db. Probable mis-trip, code bad.
38/1	118	sio3	4	Nutrients low, apparent mis-trip. Code nutrients bad.
38/1	119	reft	3	SBE35T +0.040 vs CTDT1; somewhat unstable SBE35T reading, code questionable.
38/1	119	salt	3	Salt bottle value +0.007 vs CTDS1 (PSU) at ˜500 db.
38/1	124	CTDT2	3	CTDT2 +0.015/+0.025 vs CTDT1/SBE35T; code CTDT2 questionable.
38/1	128	no3	2	High compared to adjoining stations. Corresponding peak in po4 and o2. No analytic errors.
38/1	128	po4	2	High compared to adjoining stations. Corresponding peak in no3 and o2. No analytic errors.
39/1	102	salt	2	Salt analyst: substandard run as sample 98. batch A09 bottle 339.
39/1	104	reft	3	SBE35T +0.005 vs CTDT1/CTDT2 (deep); code questionable.
39/1	113	o2	2	O2 sample value +4 umol/kg vs. down cast and high for up casts as well. Supporting features seen in sio3 and transmissometer.
39/1	116	salt	3	Bottle salts value -0.008 (PSU) vs profile, questionable for 540db. Salt analyst: thimble came off with cap #16.
39/1	118	bottle	3	Bot 18 tripped on-the-fly at 452.7db.
39/1	118	reft	3	SBE35T +0.055/-0.065 vs CTDT1/CTDT2; unstable SBE35T reading/tripped on-the-fly, code questionable.
39/1	123	o2	3	O2 sample value +5 umol/kg vs. down cast and high for up casts as well. No corroborating feature in other profiles.
39/1	127	reft	3	SBE35T +0.020/+0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
39/1	129	salt	2	Salt analyst: substandard ran as sample 98. batch A09 bottle 341.
40/1	108	o2	2	High end point titration ˜0.0005.
40/1	109	salt	2	BTL8 Thimble came out with cap.
40/1	117	bottle	5	Bottom end cap did not close. Sample lost.
40/1	118	o2	4	O2 value 150 umol/kg low vs CTDO, code sample bad.
40/1	120	bottle	2	Vent loose.
40/1	120	reft	3	SBE35T +0.040 vs CTDT1; unstable SBE35T reading, code questionable.
40/1	126	o2	4	O2 sample -195 umol/kg with down cast. O2 analyst: Titration aborted. Prev add 0.5630 Thio, 1ml std (-.05584).
40/1	131	bottle	2	Tripped extra bot 31 for DNA sample only.
41/2	201	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	202	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	203	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	204	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.

Station /Cast	Sample No.	Quality Property	Code	Comment
41/2	205	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	206	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	207	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	208	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	209	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	210	o2	2	O2 analyst: Oxygen titration rig set to read low oxygen values. Titration took longer than normal. O2 bottle value matches CTDO2, and trends in adjacent profiles.
41/2	212	reft	3	SBE35T +0.020/+0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
41/2	217	no3	2	Low for all nutrients compared to adjoining stations. Corresponding high peak in O2.
41/2	217	po4	2	Low for all nutrients compared to adjoining stations. Corresponding high peak in O2.
41/2	217	sio3	2	Low for all nutrients compared to adjoining stations. Corresponding high peak in O2.
41/2	227	ctds2	3	CTDT2/CTDS2 off, CTDS2 +0.01 vs bottle salt; code CTDS2 questionable.
41/2	227	reft	3	SBE35T +0.040 vs CTDT1; unstable SBE35T reading, code questionable.
42/1	105	salt	2	Salt analyst: Thimble came off with cap #5.
42/1	112	reft	3	REFT -0.015/-0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
42/1	114	o2	2	O2 analyst: 3 Titration aborted.
42/1	124	o2	2	O2 analyst: This line 01 23 -jkc.
43/1	101	reft	3	SBE35T -0.010 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
43/1	102	salt	3	Salt bottle value +0.007/0.010 vs. CTDS1/CTDS2. Salt analyst: thimble came off with cap#2.
43/1	104	salt	4	Salt bottle value +0.244/0.426 (PSU) vs. CTDS1/CTDS2.
43/1	111	reft	3	SBE35T +0.025/+0.035 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
43/1	111	salt	3	Salt bottle value +0.013/+0.017 (PSU) vs. CTDS1/CTDS2.
44/2	212	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.4259 end point failed should be ˜0.4565 2nd end point ˜0.5128.
44/2	217	no3	3	Bottle value +6umol/kg high for profile and adjacent casts. Probable mis-trip.
44/2	217	po4	3	Bottle value +0.5umol/kg high for profile and adjacent casts. Probable mis-trip.
44/2	217	sio3	3	Bottle value +16umol/kg high for profile and adjacent casts. Probable mis-trip.
44/2	223	reft	3	SBE35T +0.035/+0.020 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
44/2	232	reft	3	SBE35T +0.035 vs CTDT1; very unstable SBE35T reading, code questionable.
44/2	233	reft	3	SBE35T -0.120/-0.125 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
46/1	102	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.4086 pulled pipette tip out before it finished titrating, then tried to over-titrate. probably bad data.
46/1	102	salt	3	Salt value +0.054/0.056 vs CTDS1/CTDS2, questionable for 2500db.
46/1	103	bottle	5	Spigot open, sample lost.
46/1	105	salt	2	Salt analyst: thimble came off with cap #5.
46/1	109	salt	2	Salt analyst: thimble came off with cap #9.
46/1	116	o2	2	wrong flask number fixed.
46/1	123	reft	3	SBE35T +0.030 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
46/1	126	salt	2	Salt analyst: thimble came off with cap #26.
47/1	102	o2	2	O2 analyst: High titration end point ˜0.0008 (should be ˜0.4146). O2 bottle value matches CTDO2, and trends in adjacent profiles.
47/1	104	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
47/1	105	salt	3	Bottle salt +0.0021/0.003 vs CTDS1/CTDS2, questionable for ˜2020db.
47/1	113	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
47/1	114	o2	2	O2 analyst: High titration end point ˜0.003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
47/1	116	o2	3	O2 analyst: High titration end point ˜0.0007 (end point ˜.5280). O2 bottle value 4 umol/kg vs CTDO2.
48/1	101	o2	2	O2 analyst: High end point (O2 check 0.40144). Corrected end point. O2 bottle value matches CTDO2, and trends in adjacent profiles.
48/1	101	salt	3	Bottle salt value +0.0023/0.0024 vs. CTDS1/CTDS2, questionable for 3025db
48/1	105	salt	3	Bottle salt value +0.005/0.005 vs. CTDS1/CTDS2, questionable for 1900db. Salt analyst: thimble came off with cap #5.
48/1	107	o2	2	O2 analyst: High end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
48/1	114	o2	2	O2 analyst: High end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
48/1	122	o2	2	O2 sample +18 umol/kg vs down cast profile, but matches up cast.
48/1	126	salt	2	Salt analyst: thimble came off with cap #26.
48/1	129	o2	2	O2 analyst: High end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
49/2	201	salt	2	Salt analyst: thimble came off with cap #1.
49/2	210	salt	3	Bottle salt value +0.007/0.006 (PSU) vs CTDS1/CTDS2, questionable for 1000db.
49/2	212	salt	2	Salt analyst: BTL12 Thimble came out with cap - readings erratic.
49/2	213	o2	2	O2 analyst: End point ˜0.5027. End point from O2check. O2 bottle value matches CTDO2, and trends in adjacent profiles.
49/2	215	salt	2	Salt analyst: BTL15 Suspect contamination from previous sample from draw tube.
49/2	216	salt	2	Salt analyst: BTL16 Thimble came out with cap.
49/2	217	o2	2	O2 analyst: End point way too off use O2 check. End point from O2check. O2 bottle value matches CTDO2, and trends in adjacent profiles.
49/2	223	reft	3	SBE35T +0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
49/2	225	reft	3	SBE35T -0.035/-0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
50/1	101	salt	3	Bottle salt value +0.007/+0.008 (PSU) vs profile, questionable for 580db.
50/1	103	reft	3	SBE35T +0.040/+0.050 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
50/1	103	salt	3	Bottle salt value -0.014/0.011 vs CTDS1/CTDS2, questionable for 500db.
50/1	110	o2	2	O2 analyst: High end point ˜0.0003 hi. End point from O2check. O2 bottle value matches CTDO2, and trends in adjacent profiles.
50/1	111	o2	2	O2 analyst: High end point ˜0.0004 hi. End point from O2check. O2 bottle value matches CTDO2, and trends in adjacent profiles.
50/1	113	reft	3	SBE35T -0.020/-0.035 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
50/1	117	o2	2	O2 analyst: Biological particles observed in sample during titration. O2 bottle value matches CTDO2, and trends in adjacent profiles.
52/1	106	reft	3	SBE35T +0.003 vs CTDT1/CTDT2 (deep); unstable SBE35T reading for deep, code questionable.
52/1	108	salt	2	Salt analyst: BTL 8 forgot to wipe draw tube before putting sample on - thimble loose in bottle pushed back down and possibly pushed liquid from between thimble and bottle into the sample.
52/1	112	salt	3	Bottle salt value +0.006/0.006 vs CTDS1/CTDS2, questionable for 1575db, possible contamination. Salt analyst: BTL 12 - thimble came off with cap.
52/1	116	o2	2	wrong flask number corrected.
52/1	120	no2	4	Sampling error
52/1	120	no3	4	Sampling error
52/1	120	po4	4	Sampling error
52/1	120	sio3	4	Sampling error
52/1	123	salt	2	Salt analyst: BTL 23 readings kept climbing, classic contamination pattern.
52/1	131	reft	3	SBE35T +0.055/+0.060 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
52/1	133	reft	3	SBE35T +0.040/+0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
52/1	134	salt	4	Bottle salt values high vs profile. Salt analyst: BTL 34 Readings erratic, reran accidentally. Don’t trust readings.
53/1	101	o2	2	O2 analyst: High end point ˜0.0002 hi. O2 bottle value matches CTDO2, and trends in adjacent profiles.
53/1	101	salt	2	Salt analyst: thimble came off with cap #1.
53/1	102	o2	2	O2 analyst: High end point ˜0.0003 hi. O2 bottle value matches CTDO2, and trends in adjacent profiles.
53/1	105	salt	3	Bottle salt value +0.012/0.012 (PSU) vs. CTDS1/CTDS2, questionable for 1311db.
53/1	110	o2	2	O2 analyst: High end point ˜0.0003 hi. O2 bottle value matches CTDO2, and trends in adjacent profiles.
53/1	114	o2	2	O2 analyst: Sample was overtitrated and backtitrated. Over titrated less 0.3 more titers = 0.67640 + 3(i0.67640-0.73227). O2 bottle value matches CTDO2, and trends in adjacent profiles.
53/1	120	o2	2	O2 bottle value +8 umol/kg vs down cast, but matches up cast.
53/1	121	o2	2	O2 bottle value -8 umol/kg vs down cast, but matches up cast.
53/1	122	CTDT2	3	CTDT2 -0.020/-0.035 vs CTDT1/CTDT2; somewhat unstable reading, code SBE35T questionable.
53/1	123	CTDT2	3	CTDT2 +0.020/+0.040 vs CTDT1/CTDT2; somewhat unstable reading, code SBE35T questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
54/1	112	reft	3	SBE35T +0.035 vs CTDT1: unstable SBE35T reading, code questionable.
54/1	114	salt	2	Salt analyst: samples 14 and 15 switched in case.
54/1	115	salt	2	Salt analyst: samples 14 and 15 switched in case.
54/1	125	reft	3	SBE35T +0.050/+0.045 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
55/2	216	o2	2	wrong flask number corrected.
55/2	229	salt	2	Salt analyst: BTL29 Thimble came out with cap.
56/1	105	salt	2	Salt analyst: BTL5 Thimble jarred loose by cap - readings erratic.
56/1	131	reft	3	SBE35T -0.055 vs CTDT1; very unstable SBE35T reading, code questionable.
57/1	102	o2	2	O2 analyst: High end point ˜0.0003. End point from O2check program. O2 bottle value matches CTDO2, and trends in adjacent profiles.
57/1	108	salt	3	Bottle salt sample +0.004/0.004
57/1	115	o2	2	O2 analyst: High end point ˜0.0002. End point from O2check program. O2 bottle value matches CTDO2, and trends in adjacent profiles.
57/1	116	salt	3	Bottle salt sample +0.007/0.007
57/1	118	o2	2	O2 analyst: High end point ˜0.0003. End point from O2check program. O2 bottle value matches CTDO2, and trends in adjacent profiles.
57/1	120	o2	2	O2 analyst: High end point ˜0.0003. End point from O2check program. O2 bottle value matches CTDO2, and trends in adjacent profiles.
57/1	123	reft	3	SBE35T +0.050 vs CTDT1; very unstable SBE35T reading, code questionable.
57/1	127	salt	3	Bottle salt -0.015/-0.010 vs CTDS1/CTDS2, code questionable.
57/1	131	salt	4	Salt analyst: thimble came off with cap #31. Bottle salt +0.015 vs CTDS1/CTDS2, code questionable.
58/1	107	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
58/1	110	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
58/1	118	reft	3	SBE35T +0.025 vs CTDT1; unstable SBE35T reading, code questionable.
58/1	121	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
58/1	123	salt	3	Bottle salt value -0.007/0.008 (PSU) vs. profile, questionable for 500db
58/1	126	salt	2	Salt analyst: thimble came off with cap #26.
58/1	128	CTDT2	3	CTDT2 +0.035 vs CTDT1/SBE35T; code questionable.
58/1	129	reft	3	SBE35T +0.030/+0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
59/2	226	reft	3	SBE35T +0.045 vs CTDT1; unstable SBE35T reading, code questionable.
59/2	236	salt	2	Salt analyst: thimble came off with cap #36.
60/1	113	o2	2	O2 analyst: High end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
60/1	115	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
60/1	117	o2	2	O2 analyst: High end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
60/1	118	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
60/1	122	reft	3	SBE35T -0.025/-0.035 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
60/1	123	salt	2	Salt analyst: BTL23 thimble came out with cap.

Station /Cast	Sample No.	Quality Property	Code	Comment
60/1	127	reft	3	SBE35T +0.035/+0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
61/3	301	no2	5	Sampling error
61/3	301	no3	5	Sampling error
61/3	301	po4	5	Sampling error
61/3	301	sio3	5	Sampling error
61/3	308	salt	2	Salt analyst: thimble came off with cap #8.
61/3	312	salt	2	Salt analyst: thimble came off with cap #12.
61/3	316	salt	2	Salt analyst: thimble came off with cap #16.
62/1	116	o2	2	wrong flask number corrected.
62/1	121	salt	3	Salt analyst: thimble came off with cap #21. Bottle salt value +0.007/0.007 vs CTDS1/CTDS2, questionable for 700db.
62/1	136	CTDT2	3	CTDT2 +0.060 vs CTDT1; code questionable.
62/1	136	reft	3	SBE35T -0.040 vs CTDT1; very unstable SBE35T reading, code questionable.
62/1	136	salt	2	Salt analyst: thimble came off with cap #36.
63/1	103	o2	5	o2 analyst: software froze up, sample lost
63/1	104	o2	3	apparently this sample also affected by software freeze-up; bottle o2 low vs CTDO, code questionable.
63/1	105	salt	3	Bottle salt value +0.0024/+0.002 vs profile, questionable for 3100db.
63/1	119	salt	2	Salt analyst: thimble came off with cap #19.
63/1	127	ctds2	3	CTDS2 +0.020/+0.010 vs salt/CTDS1, code questionable.
63/1	127	reft	3	SBE35T +0.020/+0.060 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
63/1	128	reft	3	SBE35T +0.030/+0.035 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
64/1	104	o2	2	O2 analyst: High end point 0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
64/1	122	salt	3	Bottle salt +0.009/0.013 vs. profile, questionable for 600db.
64/1	127	o2	2	O2 analyst: High end point 0.0002. O2 bottle value -4 umol/kg vs CTDO2, however matches trends in adjacent profiles.
64/1	131	o2	2	O2 analyst: High end point 0.0001. O2 bottle value matches CTDO2, and trends in adjacent profiles.
64/1	132	o2	2	O2 analyst: High end point 0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
65/2	209	o2	2	O2 analyst: High end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
65/2	215	o2	2	O2 analyst: High end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
65/2	226	bottle	4	Nutrients high vs nearby stations; oxygen slightly high vs CTDO, salt low vs CTDS. Code as probable mis-trip.
65/2	226	no2	4	Nutrients high compared to adjacent stations. No analytical errors noted. Probable mis-trip, code bad.
65/2	226	no3	4	Nutrients high compared to adjacent stations. No analytical errors noted. Probable mis-trip, code bad.
65/2	226	po4	4	Nutrients high compared to adjacent stations. No analytical errors noted. Probable mis-trip, code bad.
65/2	226	salt	4	Bottle salt value -0.28 vs. CTDS1/CTDS2, nutrients also high. Probable mis-trip, code salt bad.
65/2	226	sio3	4	Nutrients high compared to adjacent stations. No analytical errors noted. Probable mis-trip, code bad.

Station /Cast	Sample No.	Quality Property	Code	Comment
65/2	235	reft	3	SBE35T +0.030/+0.060 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
66/1	112	salt	3	Bottle salt value +0.018/+0.018 (PSU) vs CTDS1/CTDS2, questionable for 1650db.
67/1	112	salt	3	Bottle salt value +0.005/+0.005 (PSU) vs. profile, questionable for 1400db.
67/1	116	salt	3	Bottle salt value +0.006/+0.006 (PSU) vs. profile, questionable for 1000db.
67/1	125	o2	2	High titration end point ˜0.0020. Bottle matches the cast profile.
67/1	132	salt	3	Bottle salt +0.015 vs CTDS1/CTDS2, code questionable.
67/1	133	reft	3	SBE35T +0.030/+0.060 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
68/2	205	o2	2	High titration end point ˜0.0002. Sample matches cast profile.
68/2	207	o2	2	High titration end point ˜0.0007. Sample matches cast profile.
68/2	207	reft	3	SBE35T +0.005 vs CTDT1/CTDT2 (deep); unstable SBE35T reading, code questionable.
68/2	208	o2	2	High titration end point ˜0.0002. Sample matches cast profile.
68/2	210	o2	2	High titration end point ˜0.0005. Sample matches cast profile.
68/2	211	o2	2	High titration end point ˜0.0003. Sample matches cast profile.
68/2	212	o2	2	High titration end point ˜0.0002. Sample matches cast profile.
68/2	221	o2	2	High titration end point ˜0.0010. Sample matches cast profile.
68/2	225	o2	2	High titration end point ˜0.0002. Sample matches cast profile.
68/2	231	reft	3	SBE35T -0.055/-0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
68/2	232	CTDT2	3	CTDT2 -0.180 vs CTD1; unstable reading, code questionable.
68/2	232	reft	3	SBE35T +0.050/-0.130 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
68/2	232	salt	3	Bottle salt +0.021 vs CTDS1, questionable for surface bottle.
69/2	202	o2	2	O2 analyst: High titration end point ˜0.0003. Sample matches cast profile.
69/2	207	o2	2	O2 analyst: Further titration aborted - 3 ABORT. Sample matches cast profile.
69/2	208	salt	3	Bottle salt value +0.010/0.010 (PSU) vs. CTDS1/CTDS2, questionable for 841db.
69/2	212	o2	2	O2 analyst: High titration end point ˜0.0006. Sample matches cast profile.
69/2	213	o2	2	O2 analyst: High titration end point ˜0.0002. Sample matches cast profile.
69/2	214	o2	2	O2 analyst: High titration end point ˜0.0005. Sample matches cast profile.
69/2	216	o2	2	O2 analyst: High titration end point ˜0.0003. Sample matches cast profile.
69/2	220	o2	2	O2 analyst: High titration end point ˜0.0002. Sample matches cast profile.
70/1	101	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	102	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	103	salt	3	Salt bottle value -0.003/0.003 (PSU) vs. profile, questionable for 2700db.
70/1	104	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.

Station /Cast	Sample No.	Quality Property	Code	Comment
70/1	105	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	106	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	107	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	108	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	109	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	110	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	111	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	112	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	113	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	114	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	115	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	116	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.

Station /Cast	Sample No.	Quality Property	Code	Comment
70/1	117	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	118	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	119	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	120	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	121	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	122	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	123	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	124	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	125	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	126	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	127	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	128	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.

Station /Cast	Sample No.	Quality Property	Code	Comment
70/1	129	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	130	reft	3	SBE35T +0.025/+0.020 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
70/1	130	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	131	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
70/1	132	reft	3	SBE35T -0.060/-0.020 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
70/1	132	salt	2	Deep salts low by 0.005 vs CTDS. Assumed end standard is correct, adjusted sample conductivity ratios accordingly. Salts now 0.001 high, probably a small drift during run. Salts within acceptable ranges, code acceptable.
71/1	105	salt	2	Salt analyst: Thimble came out with cap suspect contamination
71/1	121	salt	2	Salt analyst: Thimble came out with cap readings erratic
71/1	126	o2	5	Program froze during titration - sample lost.
71/1	127	o2	4	O2 analyst: High titration end point ˜0.003. O2 sample +13umol/kg high for down & up cast profiles.
72/2	201	salt	3	Salt bottle values [-0.003,-0.005] (PSU) vs profile, questionable for 3200db.
72/2	202	salt	3	Salt bottle values [-0.003,-0.005] (PSU) vs profile, questionable for 3200db.
72/2	203	salt	3	Salt bottle values [-0.003,-0.005] (PSU) vs profile, questionable for 3200db.
72/2	204	salt	3	Salt bottle values [-0.003,-0.005] (PSU) vs profile, questionable for 3200db.
72/2	205	salt	3	Salt bottle values [-0.003,-0.005] (PSU) vs profile, questionable for 3200db.
72/2	210	salt	3	Salt bottle values -0.006/-0.005 (PSU) vs CTDS1/CTDS2, questionable for 1300db.
72/2	227	o2	2	O2 analyst: High titration end point ˜0.0002. Bottle value 2umol/kg vs CTDO2 (within limits), value matches cast profile.
73/2	205	o2	2	O2 analyst: High titration end point ˜0.0002. Bottle value matches cast profile.
73/2	205	salt	2	Salt analyst: thimble came off with cap #5.
73/2	207	o2	2	O2 analyst: High titration end point ˜0.0002. Bottle value matches cast profile.
73/2	216	o2	2	O2 analyst: High titration end point ˜0.0002. Bottle value matches cast profile.
73/2	220	reft	3	SBE35T -0.015/-0.020 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
73/2	224	o2	2	O2 analyst: High titration end point ˜0.0003. Bottle value matches cast profile.
73/2	228	reft	3	SBE35T +0.210/+0.185 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
74/1	112	salt	2	Salt analyst: thimble came off with cap #12
74/1	116	o2	2	wrong flask number corrected.
74/1	116	salt	2	Salt analyst: thimble came off with cap #16
74/1	117	bottle	2	Air leak on 17. O-ring popped.
74/1	117	salt	3	Bottle salt value +0.014/0.014 (PSU) vs. profile, questionable for 810db.
74/1	120	o2	3	O2 bottle value -4 umol/kg for up and down cast.
74/1	121	o2	3	O2 bottle value +8 umol/kg for up and down cast.

Station /Cast	Sample No.	Quality Property	Code	Comment
74/1	131	reft	3	SBE35T +0.045 vs CTDT1; somewhat unstable SBE35T reading, code questionable.
74/1	131	salt	2	Salt analyst: thimble came off with cap #31.
75/1	104	reft	3	SBE35T +0.002 vs CTDT1/CTDT2 (deep); unstable SBE35T reading for deep, code questionable.
75/1	135	reft	3	SBE35T +0.090 vs CTDT1; unstable SBE35T reading, code questionable.
75/1	136	reft	3	SBE35T -0.040/-0.015 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
75/1	136	salt	3	Bottle salt sample +0.023/0.027 vs. profile, high surface sample. thimble came off with cap #36.
76/1	120	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
76/1	129	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
76/1	133	reft	3	SBE35T +0.030 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
76/1	134	reft	3	SBE35T -0.065/-0.070 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
76/1	135	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
76/1	136	o2	2	O2 analyst: Run out of order. O2 bottle value matches CTDO2, and trends in adjacent profiles.
77/2	203	salt	3	Bottle salt value -0.002 vs CTDS1/CTDS2, questionable for 5500db. Code questionable.
77/2	205	salt	3	Bottle salt value +0.005/0.004 vs CTDS1/CTDS2, questionable for 5000db. Salt analyst: thimble came off with cap #5
77/2	217	salt	3	Bottle salt value +0.018/0.018 vs CTDS1/CTDS2, questionable for 1500db. Salt analyst: thimble came off with cap #17
77/2	224	bottle	2	Accidentally fired at same depth as btl 23, 700m.
77/2	225	salt	2	Salt analyst: thimble came off with cap #25
77/2	228	salt	2	Salt analyst: thimble came off with cap #28
77/2	232	salt	2	Salt analyst: thimble came off with cap #32
77/2	236	salt	2	Salt analyst: started run with bottle 36 by accident, returned to doing bottle 1 after.
78/1	117	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.4671. O2 bottle value matches CTDO2, and trends in adjacent profiles.
78/1	129	salt	2	Salt analyst: thimble came off with cap #29
79/1	101	bottle	2	Wrong bottom ocean depth recorded on console log for bottom of cast; averaged BE and EN depths to get a value to enter.
79/1	105	o2	2	O2 analyst: High titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles.
79/1	106	o2	4	O2 bottle value -20 umol/kg vs CTDO profile. O2 analyst: Sample was overtitrated and backtitrated. 0.0587.
79/1	120	bottle	2	Tripped bottle after waiting only 5 seconds vs usual 30 seconds.
79/1	127	o2	2	O2 analyst: High titration end point 0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
79/1	128	o2	2	O2 analyst: High titration end point 0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
79/1	135	reft	3	SBE35T -0.120/-0.145 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
80/2	202	salt	3	Bottle salt value +0.0024/0.0027 (PSU) vs. CTDS1/CTDS2, questionable for 5700db.
80/2	204	salt	2	Salt analyst: thimble came off with cap #4.
80/2	216	bottle	2	Bottle fired deeper than planned, wrong wireout given to winch.
80/2	228	salt	2	Salt analyst: thimble came off with cap #28.
81/2	220	bottle	2	bottle tripped without waiting after winch stopped; usually 30 seconds.
82/1	108	salt	2	Salt analyst: thimble came off with cap #8
82/1	110	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
82/1	113	salt	2	Salt analyst: thimble came off with cap #13
82/1	131	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
82/1	132	o2	2	Bottle value -11 umol/kg vs CTDO2 down cast, however matches upcast.
83/3	302	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
83/3	310	o2	2	O2 analyst: High titration end point ˜0.0030. O2 bottle value matches CTDO2, and trends in adjacent profiles.
83/3	319	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
83/3	331	salt	3	Salt bottle value +0.016/+0.017 vs. CTDS1/CTDS2, questionable for 150db.
83/3	335	reft	3	SBE35T +0.095/+0.045 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
83/3	335	salt	3	Bottle salt value +0.010/+0.015 vs CTDS1/CTDS2, code questionable.
84/1	105	salt	3	Bottle salt value +0.0025/0.003 (PSU) vs CTDS1/CTDS2, questionable for 4510db. Salt analyst: BTL5-Readings erratic
84/1	134	reft	3	SBE35T +0.045/+0.040 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
85/1	105	o2	2	O2 analyst: High titration end point ˜0.0008. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	106	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	107	salt	2	Salt analyst: BTL7-Rim chip found, seal NOT compromised
85/1	113	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	114	salt	2	Salt analyst: BTL14 Thimbled popped out prematurely.
85/1	115	o2	2	O2 analyst: High titration end point ˜0.0010. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	116	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	117	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	121	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	125	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	126	o2	2	O2 analyst: High titration end point ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles.
85/1	126	reft	3	SBE35T +0.030 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
85/1	129	bottle	2	Pressure release valve slightly loose at sample start.
85/1	129	salt	3	Bottle salt value -0.014/-0.015 vs CTDS1/CTDS2, questionable for 235db.

Station /Cast	Sample No.	Quality Property	Code	Comment
85/1	134	reft	3	SBE35T -0.030/-0.040 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
85/1	135	salt	3	Bottle salt value +0.010 vs CTDS1/CTDS2, code questionable.
86/1	102	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
86/1	111	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
86/1	113	salt	3	Bottle salt value +0.006/+0.006 (PSU) vs CTDS1/CTDS2, code questionable for 2020db.
86/1	120	o2	2	O2 analyst: High titration end point ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles.
86/1	129	bottle	2	bottle 29 fired after 15 seconds, vs usual 30 second wait.
86/1	131	no2	4	Bottle sample appears high for profile. dgs: samples 31 and 32 switched.
86/1	131	no3	4	Bottle sample appears high for profile. dgs: samples 31 and 32 switched.
86/1	131	po4	4	Bottle sample appears high for profile. dgs: samples 31 and 32 switched.
86/1	131	sio3	4	Bottle sample appears high for profile. dgs: samples 31 and 32 switched.
86/1	132	no2	4	Bottle sample appears low for profile. dgs: samples 31 and 32 switched.
86/1	132	no3	4	Bottle sample appears low for profile. dgs: samples 31 and 32 switched.
86/1	132	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.5904 1st titer bad stepping. High titration end point 0.0006. Bottle value -8 umol/kg matches upcast not down cast.
86/1	132	po4	4	Bottle sample appears low for profile. dgs: samples 31 and 32 switched.
86/1	132	sio3	4	Bottle sample appears low for profile. dgs: samples 31 and 32 switched.
87/2	216	salt	3	Bottle salt value +0.005/+0.006 (PSU) vs CTDS1/CTDS2, questionable for 1500db.
87/2	223	salt	3	Bottle salt value +0.033/+0.034 (PSU) vs CTDS1/CTDS2, questionable for 740db.
87/2	235	reft	3	SBE35T -0.025/-0.030 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
88/1	121	salt	2	Salt analyst: thimble came off with cap #21
88/1	129	no3	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip.
88/1	129	o2	2	Bottle o2 appears high compared to adjacent stations and profile, but matches feature in upcast CTDO. Code acceptable.
88/1	129	po4	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip.
88/1	129	sio3	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip.
88/1	135	reft	3	SBE35T +0.020/+0.035 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
89/2	210	bottle	2	Niskin 10 open vent.
89/2	210	o2	2	O2 analyst: High titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	211	o2	2	O2 analyst: High titration end point ˜0.0006. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	213	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	215	no3	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.
89/2	215	o2	2	O2 analyst: High titration end point. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	215	po4	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.

Station /Cast	Sample No.	Quality Property	Code	Comment
89/2	215	sio3	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.
89/2	216	no3	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.
89/2	216	o2	2	O2 analyst: High titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	216	po4	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.
89/2	216	sio3	3	All nutrients high compared to adjacent stations. No concomitant peak in o2.
89/2	217	o2	2	O2 analyst: High titration end point. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	222	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
89/2	228	reft	3	SBE35T +0.050/+0.035 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
89/2	232	bottle	2	Bottle 32 accidentally fired at bottle 31 depth while still stopped.
89/2	232	reft	3	SBE35T +0.015/+0.035 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
89/2	236	reft	3	SBE35T +0.040/+0.055 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
90/1	102	salt	3	Bottle salt value -0.004/-0.003 (PSU) vs. CTDS1/CTDS2, questionable for 5440db.
90/1	109	salt	3	Bottle salt value -0.006/-0.006 (PSU) vs. CTDS1/CTDS2, questionable for 3140db
90/1	126	salt	2	Salt analyst: thimble came off with cap #26.
90/1	130	no3	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip
90/1	130	o2	2	High compared to adjacent stations and profile, but matches upcast CTDO well. Code acceptable.
90/1	130	po4	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip
90/1	130	sio3	3	High compared to adjacent stations and profile. Corresponding peak in nuts. Possible mis-trip
90/1	131	o2	3	O2 bottle value -10 umol/kg vs profile. Questionable for 250db.
90/1	134	salt	3	Bottle salt value +0.010 (PSU) vs. CTDS1/CTDS2, code questionable.
90/1	135	salt	3	Bottle salt value +0.010/+0.015 (PSU) vs. CTDS1/CTDS2, code questionable.
91/2	216	salt	2	Salt analyst: BTL16- Thimble came out with cap.
91/2	231	salt	2	Salt analyst: BTL31- Thimble came out with cap.
92/1	101	salt	3	Bottle salt value +0.005/+0.005 (PSU) vs CTDS1/CTDS2, questionable for 2900db.
92/1	102	salt	3	Bottle salt value +0.003/+0.003 (PSU) vs CTDS1/CTDS2, questionable for 2400db.
92/1	113	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
92/1	117	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
92/1	120	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
92/1	124	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value -3 umol/kg vs CTDO2, acceptable for 100db. Value matches trends in adjacent profiles.
92/1	126	o2	5	NO reagents added after collecting sample. Sample lost.
92/1	126	reft	3	SBE35T -0.050/-0.070 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
93/2	204	o2	2	High titration end point ˜0.0003.
94/1	104	o2	2	High titration end point ˜0.0004.
94/1	106	no3	2	Low compared to adjacent stations and profile. No analytical errors noted.
95/3	303	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.5456. O2 bottle value matches CTDO2, and trends in adjacent profiles
95/3	304	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.5421. O2 bottle value matches CTDO2, and trends in adjacent profiles
95/3	305	salt	3	bottle salt value +0.003/+0.003 (PSU) vs CTDS1/CTDS2, questionable for 4160 db.
95/3	319	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
95/3	323	o2	2	O2 analyst: High titration end point ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
95/3	334	o2	2	O2 analyst: High titration end point ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
95/3	336	o2	3	O2 analyst: O2 bottle value -226 umol/kg vs profile.
96/1	105	o2	2	O2 analyst: High end point titration ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
96/1	109	o2	2	O2 analyst: High end point titration ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
96/1	113	o2	2	O2 analyst: High end point titration ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles
96/1	114	o2	2	O2 analyst: High end point titration ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
96/1	116	o2	2	O2 analyst: High end point titration ˜0.0004. O2 bottle value matches CTDO2, and trends in adjacent profiles
96/1	124	salt	2	Salt analyst: thimble came off with cap #24.
96/1	128	bottle	2	Mystery mis-trip, not triggered by Console Op; shiproll?
96/1	129	bottle	2	Mystery mis-trip, not triggered by Console Op; shiproll?
96/1	129	reft	3	SBE35T +0.08/+0.09 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
96/1	129	salt	3	Bottle salt -0.13/-0.125 vs CTDS1/CTDS2; code questionable.
96/1	130	bottle	2	Mystery mis-trip, not triggered by Console Op; shiproll?
96/1	130	ctds2	3	CTDS2 value +0.010 vs CTDS1/bottle salt; code CTDS2 questionable.
96/1	130	reft	3	SBE35T +0.01/+0.04 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
96/1	134	bottle	2	Niskin bottle tripped on the fly due to weather conditions.
96/1	135	bottle	2	Niskin bottle tripped on the fly due to weather conditions.
96/1	135	reft	3	SBE35T +0.095/+0.100 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
96/1	136	bottle	2	Niskin bottle tripped on the fly due to weather conditions.
96/1	136	ctds2	3	CTDS2 value +0.015/+0.010 vs CTDS1/bottle salt; code CTDS2 questionable.
96/1	136	CTDT2	3	Unstable readings, tripped on the fly; CTDS2 high: code CTDT2 questionable.
96/1	136	reft	3	SBE35T -0.165/-0.100 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
97/1	117	o2	3	Bottle o2 value +10 umol/kg vs profile, questionable for 1300db.
97/1	135	bottle	2	surface bottle at 15m due to large surface swell; still in surface mixed layer.
97/1	136	bottle	2	Duplicate trip at 15m for DNA sample.

Station /Cast	Sample No.	Quality Property	Code	Comment
98/1	101	o2	2	O2 analyst: High end point titration ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	102	o2	2	O2 analyst: High end point titration ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	102	salt	3	bottle salt value -0.0025 vs CTDS1/CTDS2, questionable for 5140 db.
98/1	104	o2	2	O2 analyst: High end point titration ˜0.0003. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	106	o2	2	O2 analyst: High end point titration ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	107	bottle	2	Bottle possibly opened during recovery. Broken lanyard noticed during sampling.
98/1	114	bottle	2	Winch to 1567m, then back to 1575, before tripping bottle.
98/1	116	o2	2	O2 analyst: High end point titration ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	120	o2	2	O2 analyst: High end point titration ˜0.0002. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	123	o2	2	O2 analyst: High end point titration ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
98/1	127	o2	2	O2 analyst: High end point titration ˜0.0005. O2 bottle value matches CTDO2, and trends in adjacent profiles
99/1	116	salt	2	Salt analyst: BTL16 Thimble came out with cap
99/1	130	o2	2	Bottle O2 value -10 umol/kg vs down cast profile. Matches up cast.
100/1	119	salt	3	Bottle salt +0.025 vs CTDS1/CTDS2; code questionable.
100/1	126	reft	3	SBE35T +0.035 vs CTDT1; unstable SBE35T reading, code questionable.
100/1	134	reft	3	SBE35T -0.060/-0.070 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
101/1	110	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. High titration end point ˜0.0004.
101/1	111	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. High titration end point ˜0.0004.
101/1	116	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. BTL 16 titrated out of order.
101/1	121	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. High titration end point ˜0.56907.
101/1	131	ctds2	3	CTDS2 value +0.01 vs CTDS1/bottle salt; code CTDS2 questionable.
101/1	131	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: Sample was overtitrated and backtitrated.
101/1	131	reft	3	SBE35T +0.040/+0.070 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
101/1	132	o2	3	O2 bottle value +21 umol/kg vs CTDO. O2 value does not match adjacent profiles and there are no supporting features in other profiles.
101/1	133	o2	2	O2 bottle value -22 umol/kg vs CTDO. similar feature observed in adjacent o2, sio3 and transmissometer profiles. However value does appear low.
102/1	101	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	102	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.

Station /Cast	Sample No.	Quality Property	Code	Comment
102/1	103	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	104	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	105	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	106	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	107	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	108	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	109	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	110	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	111	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	112	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	113	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	114	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	115	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	116	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	117	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	118	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	119	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.

Station /Cast	Sample No.	Quality Property	Code	Comment
102/1	120	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	121	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	122	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	123	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	124	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	125	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	126	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	127	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	128	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	128	reft	3	SBE35T +0.040 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
102/1	129	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	130	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	131	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	131	reft	3	SBE35T -0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
102/1	132	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	133	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	134	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.

Station /Cast	Sample No.	Quality Property	Code	Comment
102/1	135	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
102/1	136	CTDS1	4	Abrupt +0.3 mS/cm CTDC1 offset at 5590db downcast, +0.3 mS/cm. more at 4680-4660db upcast; use CTDT2/CTDC2 for all CTD data. code CTDS1 bad.
103/1	124	salt	2	Salt analyst: thimble came off with cap #24
103/1	132	o2	3	Bottle o2 value -10 umol/kg vs. profile. Large bubble in sample. Stopper loose.
103/1	133	reft	3	CTDT2 -0.025/-0.035 vs CTDT1/SBE35T; code questionable.
104/2	217	salt	2	Salt analyst: BTL17 Thimble came out with cap
104/2	220	salt	2	Salt analyst: BTL20 Operator error-took bottle off before second reading.
104/2	221	salt	3	Bottle salt value +0.006/+0.006 (PSU) vs profile, questionable for 900db. Salt analyst: BTL21 Thimble came out with cap.
104/2	227	salt	3	Salt analyst: BTL27 Thimble came out with cap.
105/2	226	salt	2	Salt analyst: thimble came off with cap #26
105/2	233	salt	3	Bottle salt value -0.01 vs CTDS1/CTDS2; code questionable.
106/1	106	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: Paint flake in flask.
106/1	127	salt	2	Salt analyst: thimble came off with cap #27.
106/1	128	reft	3	SBE35T +0.020 vs CTDT1/CTDT2; code SBE35T questionable.
106/1	129	salt	3	Bottle salt value -0.015 vs. CTDS1/CTDS2, questionable near surface sample.
106/1	130	reft	3	SBE35T -0.020/-0.015 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
106/1	132	o2	2	O2 bottle value +8 umol/kg with down cast, however matches upcast.
106/1	134	reft	3	SBE35T -0.040/-0.035 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
107/3	305	bottle	9	Bottle spigot sheared off during recovery, water lost. Replace with niskin s/n 37 before next cast.
107/3	308	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0003.
107/3	316	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0003.
107/3	323	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0007.
107/3	324	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0005.
107/3	329	salt	2	Salt analyst: BTL29 Thimble came out with cap.
107/3	330	reft	3	SBE35T -0.035 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
107/3	331	o2	2	O2 bottle value 6 umol/kg high vs CTDO2, however matches trend in adjacent profiles. O2 analyst: High titration end point ˜0.0003.
107/3	331	salt	2	Salt analyst: BTL31 Piece of white vinyl tape from label caught between bottle rim and thimble - seal suspect
107/3	333	o2	2	Sample was overtitrated and backtitrated
107/3	334	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0010.
107/3	334	reft	3	SBE35T -0.025/-0.02 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
108/1	105	bottle	2	Replaced s/n 05 with niskin s/n 37 before cast.

Station /Cast	Sample No.	Quality Property	Code	Comment
108/1	121	salt	2	Sal analyst: thimble came off with cap #21.
108/1	124	salt	2	Sal analyst: thimble came off with cap #24.
108/1	127	salt	2	Sal analyst: thimble came off with cap #27.
109/1	109	salt	3	Bottle salt value -0.015 vs CTDS1/CTDS2; code questionable.
109/1	131	salt	3	Bottle salt value -0.015/-0.010 vs CTDS1/CTDS2; code questionable.
110/1	110	o2	2	O2 bottle value -10 vs. down cast, however value matches up cast.
110/1	127	salt	2	Salt analyst: thimble came off with cap #27.
110/1	129	bottle	9	Inner spring launched skyward during deployment, lost both endcaps and spring. Tripped through during cast, repaired afterward.
110/1	130	bottle	3	Vent cap broken, repaired after sampling.
110/1	132	reft	3	SBE35T +0.030/+0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
111/1	111	o2	3	Bottle o2 value +3 umol/kg vs CTDO. No supporting features seen in other profiles.
111/1	121	salt	2	Salt analyst: thimble came off with cap #21
111/1	124	o2	3	Bottle o2 value low for cast and does not fit trend for adjacent profiles. Supporting features not observed in nutrient profiles.
111/1	129	bottle	2	Inner spring, endcaps replaced with spare parts from out-of-service niskin s/n 5 before cast.
111/1	130	reft	3	SBE35T +0.035/+0.020 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
112/2	205	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. O2 analyst: High titration end point ˜0.0003
112/2	212	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.0003
112/2	217	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.0002
112/2	218	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.0003
112/2	225	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.0004
112/2	226	salt	2	Salt analyst: BTL26 Thimble came out with cap
112/2	228	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.0002
112/2	232	o2	2	O2 bottle value -3umol/kg vs. CTDO2, however matches trend in adjacent profiles. High titration end point ˜0.0002
112/2	234	reft	3	SBE35T -0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
112/2	235	o2	2	O2 bottle matches CTDO2 and trend in adjacent profiles. High titration end point ˜0.002
113/2	204	reft	3	SBE35T +0.003 vs CTDT1/CTDT2; unstable SBE35T reading for deep, code questionable.
113/2	217	salt	2	salt analyst: thimble came off with cap #17
113/2	221	salt	3	Bottle salt value -0.005/-0.005 (PSU) vs profile, questionable for 900db.
113/2	230	reft	3	SBE35T +0.035 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
113/2	233	reft	3	SBE35T +0.035 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
113/2	234	reft	3	SBE35T -0.110 vs CTDT1; very unstable SBE35T reading, code questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
114/1	102	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0003
114/1	104	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0003
114/1	111	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0002
114/1	112	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0002
114/1	113	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0003
114/1	114	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0002
114/1	124	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: High titration end point ˜0.0002
114/1	127	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: Bottles switched with 128.
114/1	128	o2	2	O2 bottle value matches CTDO2, and trends in adjacent profiles. O2 analyst: Bottles switched with 127.
114/1	129	reft	3	SBE35T -0.020/-0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
114/1	134	o2	2	Sample was overtitrated and backtitrated. 0.6195 first titration bad end point.
114/1	135	o2	2	Sample was overtitrated and backtitrated. 0.5741 2 bad ep use O2check.
114/1	135	reft	3	SBE35T +0.070/+0.065 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
115/2	227	reft	3	SBE35T +0.035/+0.01 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
115/2	227	salt	2	Salt analyst: BTL27 Thimble came out with cap.
116/1	101	salt	3	Bottle salt value +0.0023/+0.003 (PSU) vs CTDS1/CTDS2. Bottle value clearly deviates from profile.
116/1	113	salt	2	Salt analyst: thimble came off with cap #13.
116/1	119	o2	2	Flasks switched 1511 for 870.
116/1	120	o2	2	Flasks switched 870 for 1511
116/1	132	salt	3	Bottle salt value +0.010 vs CTDS1/CTDS2, code questionable.
116/1	133	reft	3	SBE35T +0.040/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
117/1	101	salt	3	Bottle salt +0.005 vs CTDS1/CTDS2 (deep); code questionable.
117/1	103	o2	2	Bottle o2 value appeared low for profile. Similar features not observed in nutrient profiles, however it matches raw CTDO and fit CTDO.
117/1	106	o2	2	O2 analyst: High titration end point ˜0.0003. Bottle value appears to match profile and CTDO.
117/1	107	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	109	salt	2	salt analyst: thimble came off with cap #9.
117/1	110	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	115	o2	2	O2 analyst: high titration end point ˜0.0004. Bottle value appears to match profile and CTDO.
117/1	117	o2	2	O2 analyst: high titration end point ˜0.0008. Bottle value appears to match profile and CTDO.
117/1	119	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.

Station /Cast	Sample No.	Quality Property	Code	Comment
117/1	121	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	122	o2	2	O2 analyst: high titration end point ˜0.0003. Bottle value appears to match profile and CTDO.
117/1	124	salt	2	salt analyst: thimble came off with cap #24.
117/1	128	CTDT2	3	CTDT2 +0.04/+0.035 vs SBE35T/CTDT1; code questionable.
117/1	128	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	130	o2	2	O2 analyst: high titration end point ˜0.0003. Bottle value appears to match profile and CTDO.
117/1	132	o2	3	O2 analyst: high titration end point ˜0.0006. Bottle value low vs adjacent profiles.
117/1	133	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	135	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
117/1	136	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	104	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	107	o2	2	O2 analyst: high titration end point ˜0.0004. Bottle value appears to match profile and CTDO.
118/1	108	salt	2	salt analyst: BTL8 Thimble popped out after cap.
118/1	110	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	111	o2	2	O2 analyst: high titration end point ˜0.0004. Bottle value appears to match profile and CTDO.
118/1	113	salt	2	salt analyst: BTL13 Thimble popped out after cap.
118/1	118	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	120	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	124	o2	2	O2 analyst: high titration end point ˜0.0003, and run out of order. Bottle value appears to match profile and CTDO.
118/1	125	CTDT2	3	CTDT2 +0.030/+0.020 vs SBE35T/CTDT1; code CTDT2 questionable.
118/1	125	o2	2	O2 analyst: high titration end point ˜0.0005. Bottle value appears to match profile and CTDO.
118/1	126	o2	2	O2 analyst: high titration end point ˜0.0005. Bottle value appears to match profile and CTDO.
118/1	128	o2	2	O2 analyst: high titration end point ˜0.0015. Bottle value appears to match profile and CTDO.
118/1	129	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	133	o2	2	O2 analyst: high titration end point ˜0.0002. Bottle value appears to match profile and CTDO.
118/1	134	o2	2	O2 analyst: Sample was overtitrated and backtitrated. 0.6206. High titration end point ˜0.0006. Bottle value appears to match profile and CTDO.
118/1	134	reft	3	SBE35T +0.09 vs CTDT1; very unstable SBE35T reading, code questionable.
119/2	203	salt	3	Bottle salt value +0.004 (PSU) vs CTDS1/CTDS2, questionable for 4574db.

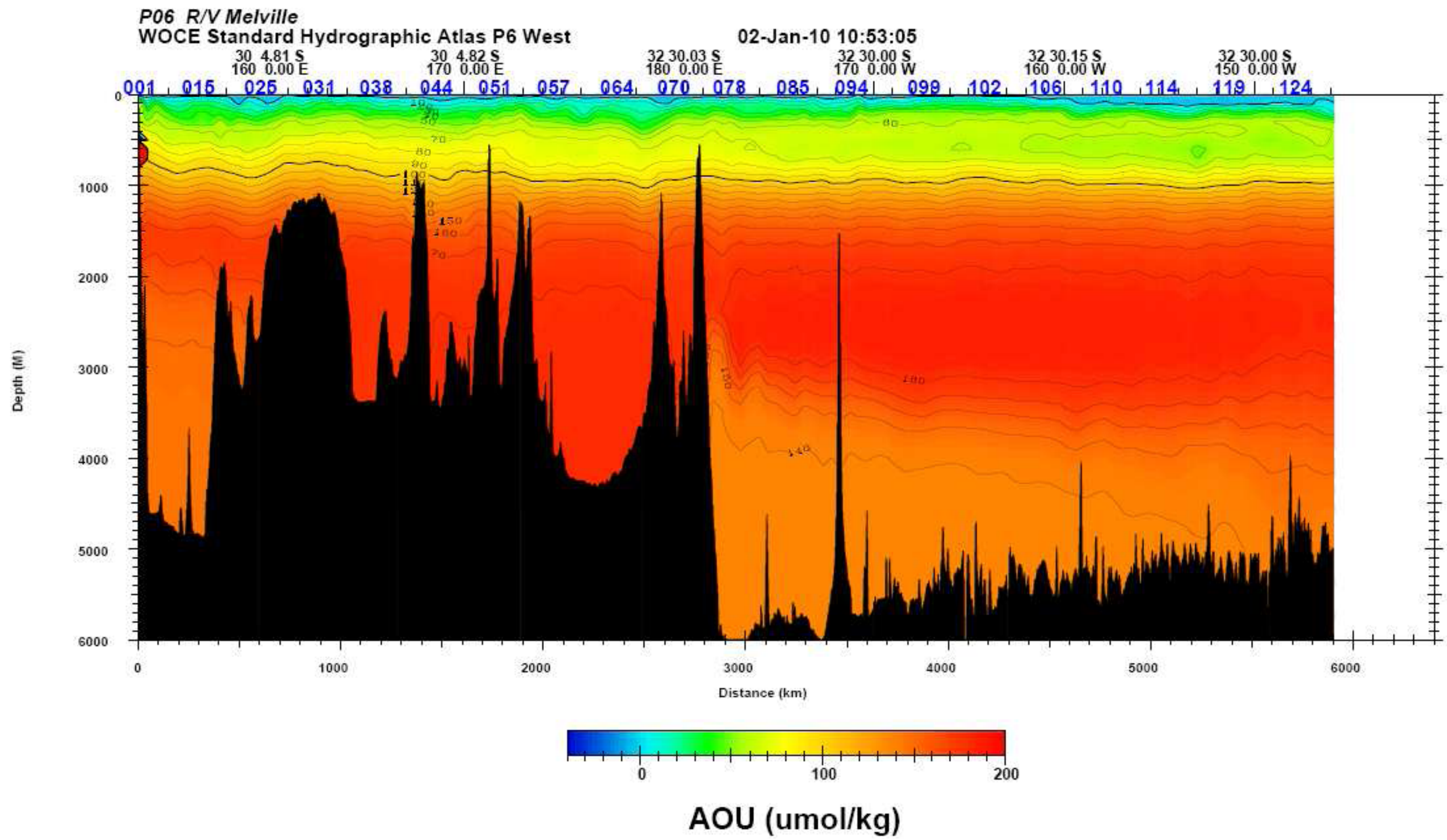
Station /Cast	Sample No.	Quality Property	Code	Comment
119/2	210	o2	3	O2 bottle value high vs profile and adjacent casts. Similar feature not observed in nutrient profiles.
119/2	219	salt	3	Bottle salt value -0.007/-0.006 (PSU) vs CTDS1/CTDS2, questionable for 1109db.
119/2	227	bottle	9	Tag line hooked bottle by lanyard, dumped out while pulling rosette in.
120/1	101	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	102	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	105	o2	3	Bottle value appears low for profile and is -5 umol/kg with CTDO. O2 analyst: High titration end point ˜0.0010.
120/1	105	salt	3	Bottle salt value -0.004/-0.004 (PSU) vs CTDS1/CTDS2, questionable for 4058db.
120/1	106	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	108	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0009.
120/1	109	salt	3	Bottle salt value -0.013/-0.012 (PSU) vs CTDS1/CTDS2, questionable for 4058db.
120/1	110	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0003.
120/1	111	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	113	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	116	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0013.
120/1	118	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	119	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0006.
120/1	120	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	122	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0003.
120/1	124	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0002.
120/1	128	reft	3	SBE35T +0.030/+0.025 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
120/1	129	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0003.
120/1	129	reft	3	SBE35T +0.030/+0.020 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
120/1	130	o2	2	Bottle value appears to match profile and CTDO. O2 analyst: High titration end point ˜0.0006.
120/1	135	reft	3	SBE35T -0.060 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
121/2	204	salt	2	Salt analyst: BTL04: thimble came off with cap.
121/2	207	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.

Station /Cast	Sample No.	Quality Property	Code	Comment
121/2	212	o2	2	O2 analyst: high titration end point ˜0.0004. O2 bottle value appears to fit profile and CTDO.
121/2	220	o2	2	O2 analyst: high titration end point ˜0.0003. O2 bottle value appears to fit profile and CTDO.
121/2	221	salt	2	Salt analyst: BTL21 thimble came off with cap.
121/2	224	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
121/2	225	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
121/2	226	salt	3	Bottle salt sample +0.016/+0.016 (PSU) vs. CTDS1/CTDS2, questionable for 387db. Salt analyst: BTL26 thimble came off with cap.
121/2	227	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
121/2	228	salt	3	Bottle salt value -0.019/-0.018 vs CTDS1/CTDS2, questionable for 300db.
121/2	229	reft	3	SBE35T +0.055 vs CTDT1; unstable SBE35T reading, code questionable.
121/2	229	salt	3	Bottle salt value -0.011/-0.021 vs. CTDS1/CTDS2, questionable for 240db.
121/2	230	o2	2	O2 analyst: high titration end point ˜0.0004. O2 bottle value appears to fit profile and CTDO.
121/2	231	o2	2	O2 analyst: high titration end point ˜0.0005. O2 bottle value appears to fit profile and CTDO.
122/1	111	salt	3	Bottle salt value -0.003 (PSU) vs CTDS1/CTDS2, questionable for 2529db.
122/1	130	reft	3	SBE35T +0.015/+0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
122/1	134	reft	3	SBE35T +0.035/+0.040 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
123/1	101	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	104	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	106	o2	2	O2 analyst: high titration end point ˜0.0004. O2 bottle value appears to fit profile and CTDO.
123/1	108	o2	2	O2 analyst: high titration end point ˜0.0013. O2 bottle value appears to fit profile and CTDO.
123/1	109	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	110	bottle	2	Vent valve open on bottle 10.
123/1	111	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	116	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	117	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	118	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	121	o2	2	O2 analyst: high titration end point ˜0.0004. O2 bottle value appears to fit profile and CTDO.
123/1	127	reft	3	SBE35T -0.025/-0.030 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
123/1	129	o2	2	O2 analyst: high titration end point ˜0.0002. O2 bottle value appears to fit profile and CTDO.
123/1	133	CTDT2	3	CTDT2 +0.030 vs SBE35T/CTDT1; code CTDT2 questionable.

Station /Cast	Sample No.	Quality Property	Code	Comment
123/1	135	o2	2	O2 analyst: high titration end point ˜0.0008. O2 bottle value appears to fit profile and CTDO.
124/1	127	reft	3	SBE35T +0.035/+0.015 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.
124/1	132	o2	2	O2 bottle value +11 umol/kg with down cast CTDO, however value matches up cast CTDO and trends in other parameter profiles.
125/2	201	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	202	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	203	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	204	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	205	o2	3	O2 bottle value -4umol/kg vs CTDO, and low for cast. No supporting features in nutrient profiles. Questionable for 3650db.
125/2	205	salt	3	Salinity bottle value -0.005 vs CTDS1/CTDS2 (deep), code salinity questionable.
125/2	206	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	207	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	208	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	209	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	210	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	211	o2	2	Low on NaI. Possible bubbles in bottles 1-11
125/2	213	salt	2	Thimble does not stay in bottle 13.
125/2	228	salt	3	Salinity bottle value +0.010/+0.015 vs CTDS1/CTDS2, code salinity questionable.
125/2	229	salt	3	Salinity bottle value -0.010 vs CTDS1/CTDS2, code salinity questionable.
126/1	127	reft	3	SBE35T +0.025/+0.040 vs CTDT1/CTDT2; very unstable SBE35T reading, code questionable.
126/1	131	reft	3	SBE35T -0.025/-0.030 vs CTDT1/CTDT2; unstable SBE35T reading, code questionable.
126/1	135	ctds2	3	CTDS2 +0.010 vs Bottle Salt/CTDS1; code CTDS2 questionable.
127/1	109	salt	2	Salt bottles 9/10 found switched in box, also run out of order. Corrected bottle numbers in data file, and fixed box order. Salinity data ok now.
127/1	110	salt	2	Salt bottles 9/10 found switched in box, also run out of order. Corrected bottle numbers in data file, and fixed box order. Salinity data ok now.
127/1	127	salt	3	Salinity bottle value +0.015 vs CTDS1/CTDS2, code salinity questionable.
127/1	135	reft	3	SBE35T +0.030/+0.035 vs CTDT1/CTDT2; somewhat unstable SBE35T reading, code questionable.

Appendix D

Preliminary Vertical Sections


P06 R/V Melville
WOCE Standard Hydrographic Atlas P6 West
02-Jan-10 10:53:05
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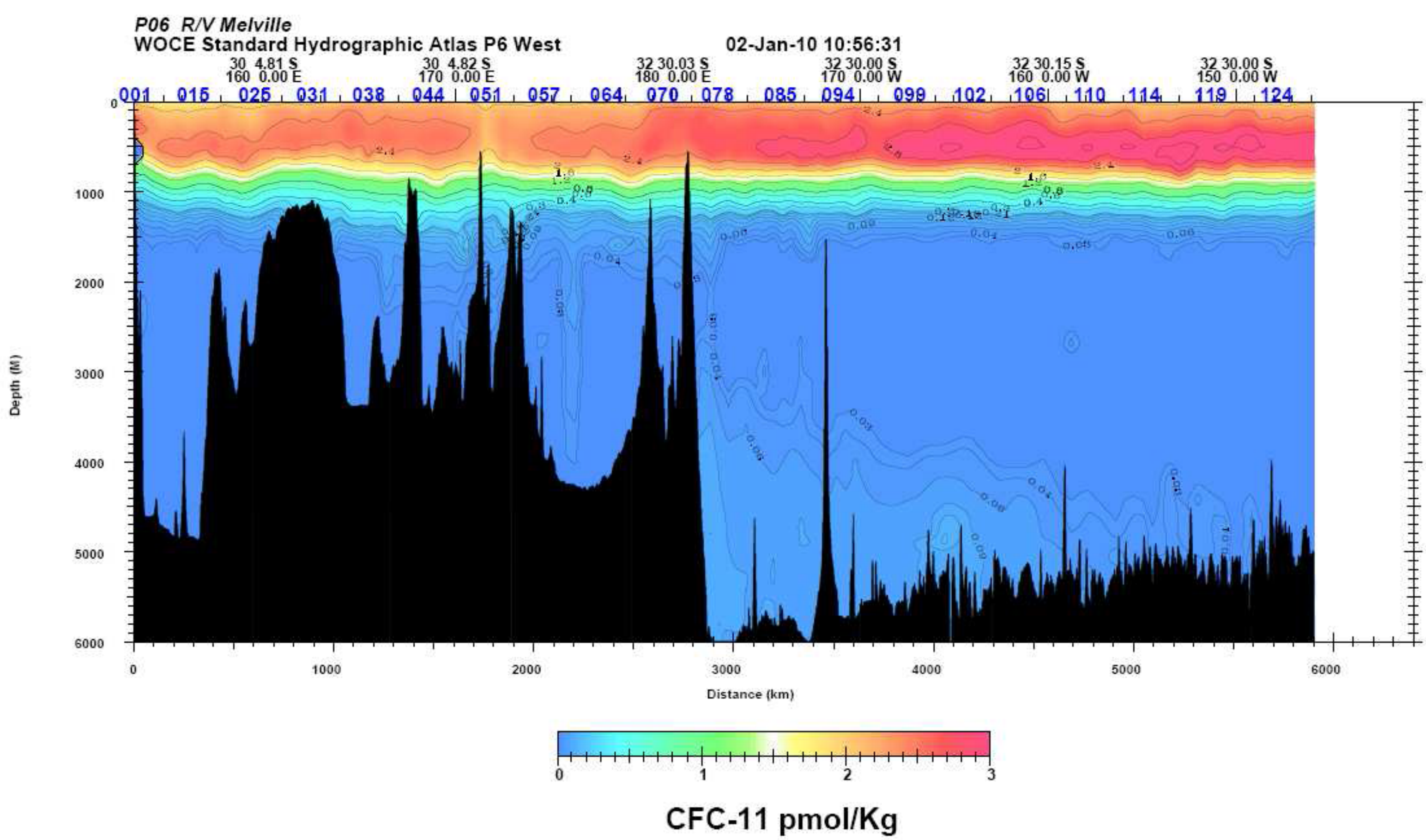
160 0.00 E
30 4.82 S
170 0.00 E
32 30.03 S
180 0.00 E
32 30.00 S
170 0.00 W
32 30.15 S
160 0.00 W
32 30.00 S
150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
AOU (umol/kg)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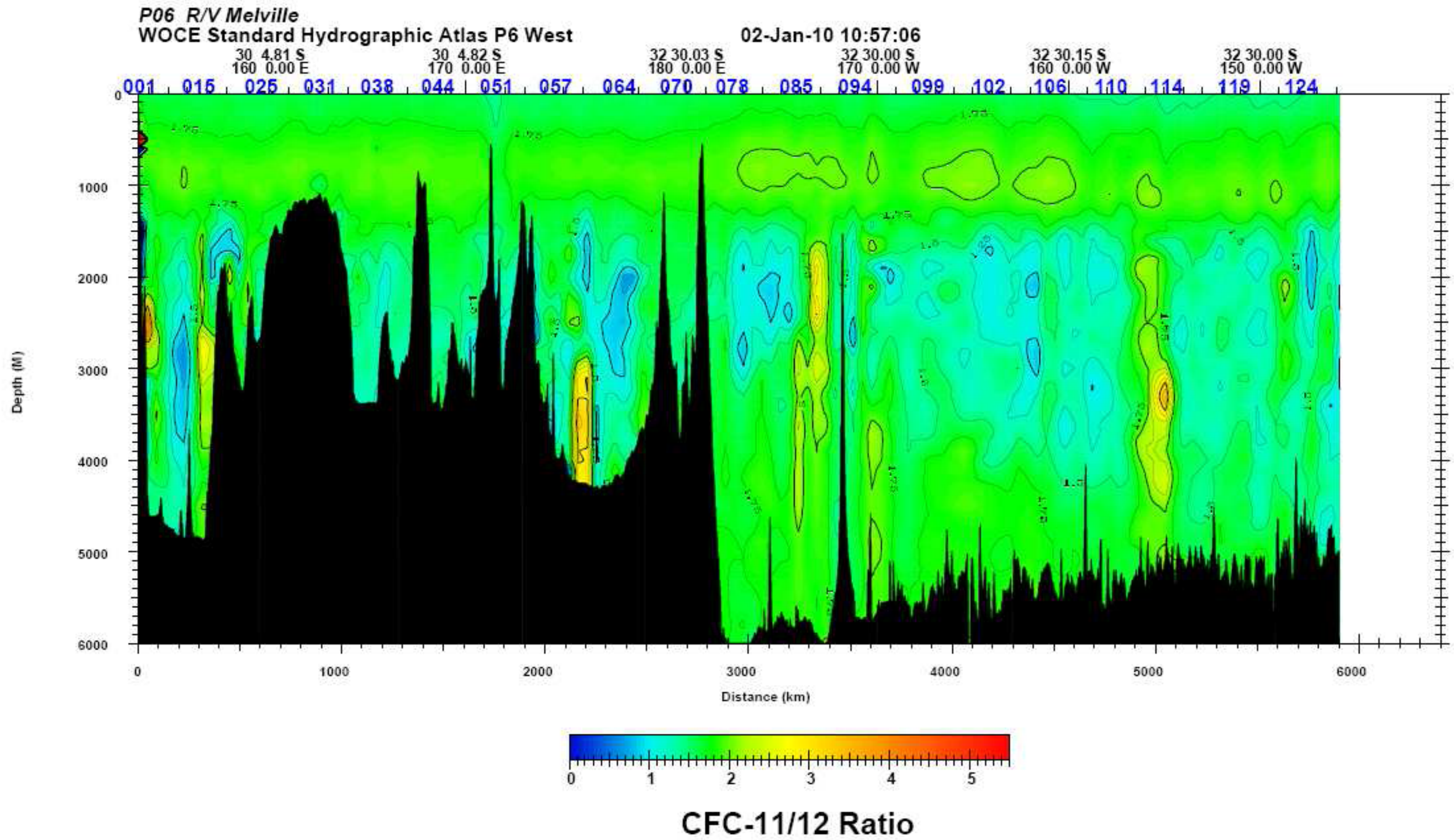
32 30.00 S
170 0.00 W
32 30.15 S
160 0.00 W
32 30.00 S
150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
CFC-11 pmol/Kg



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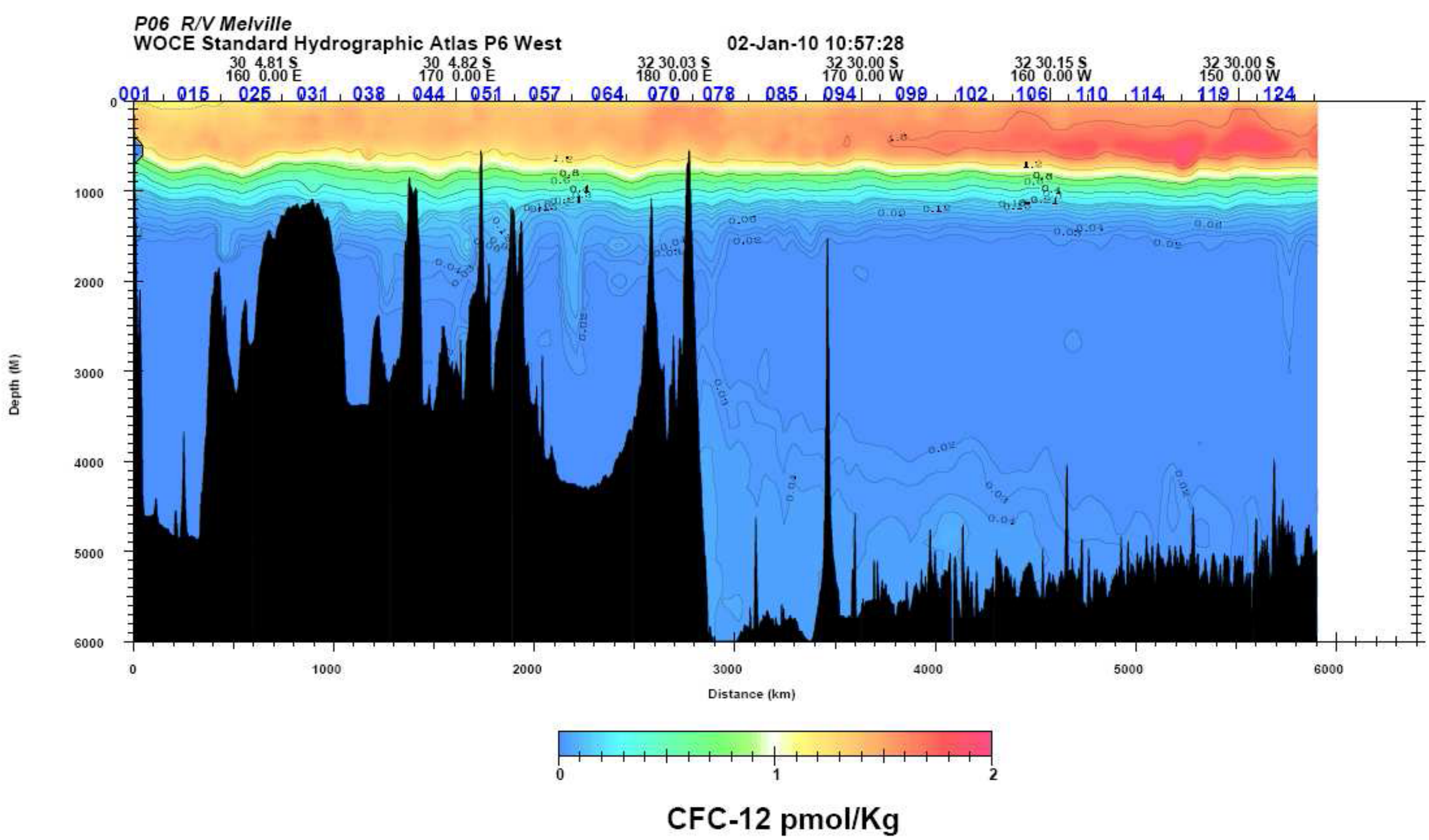
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
CFC-11/12 Ratio



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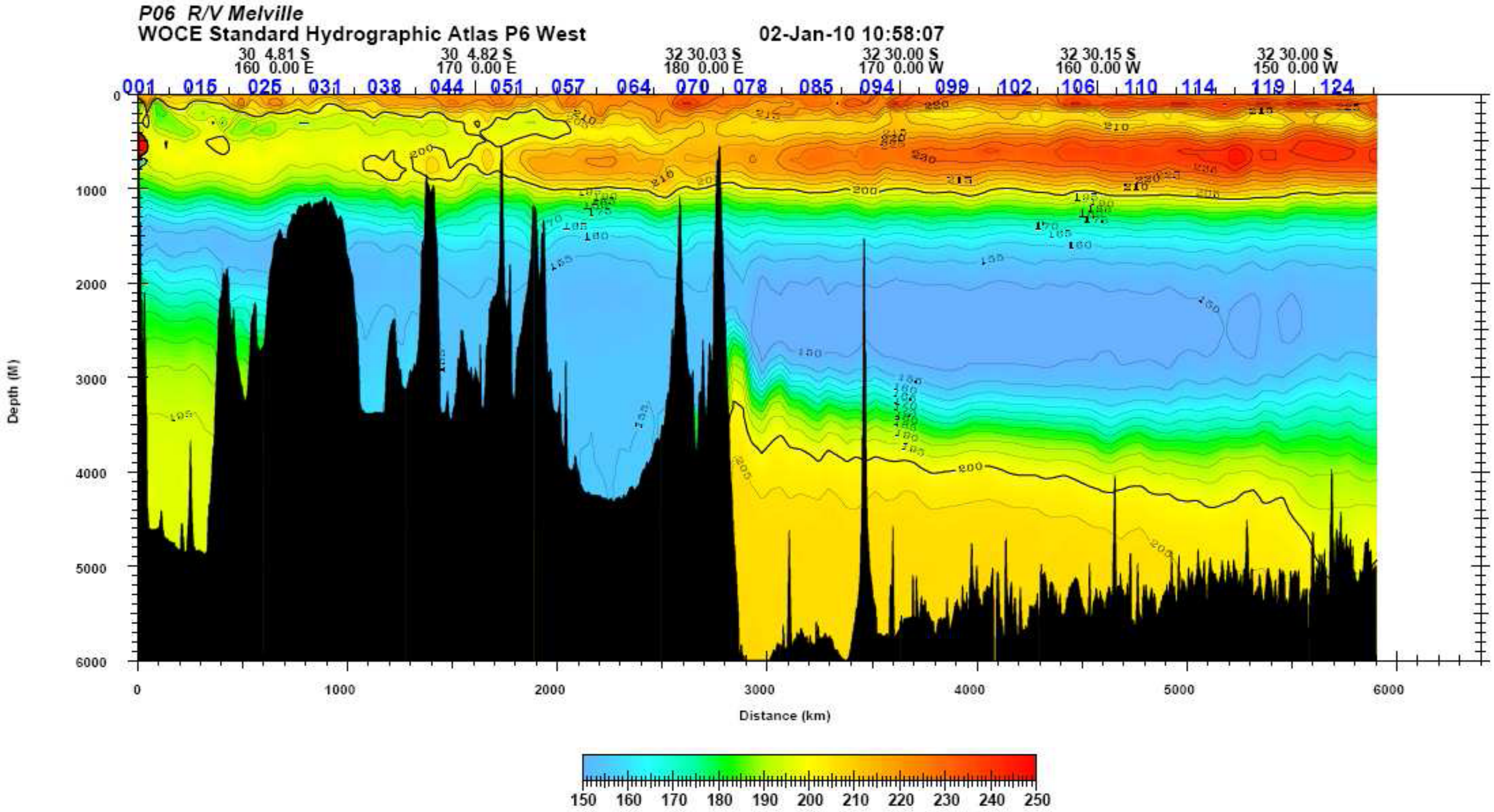
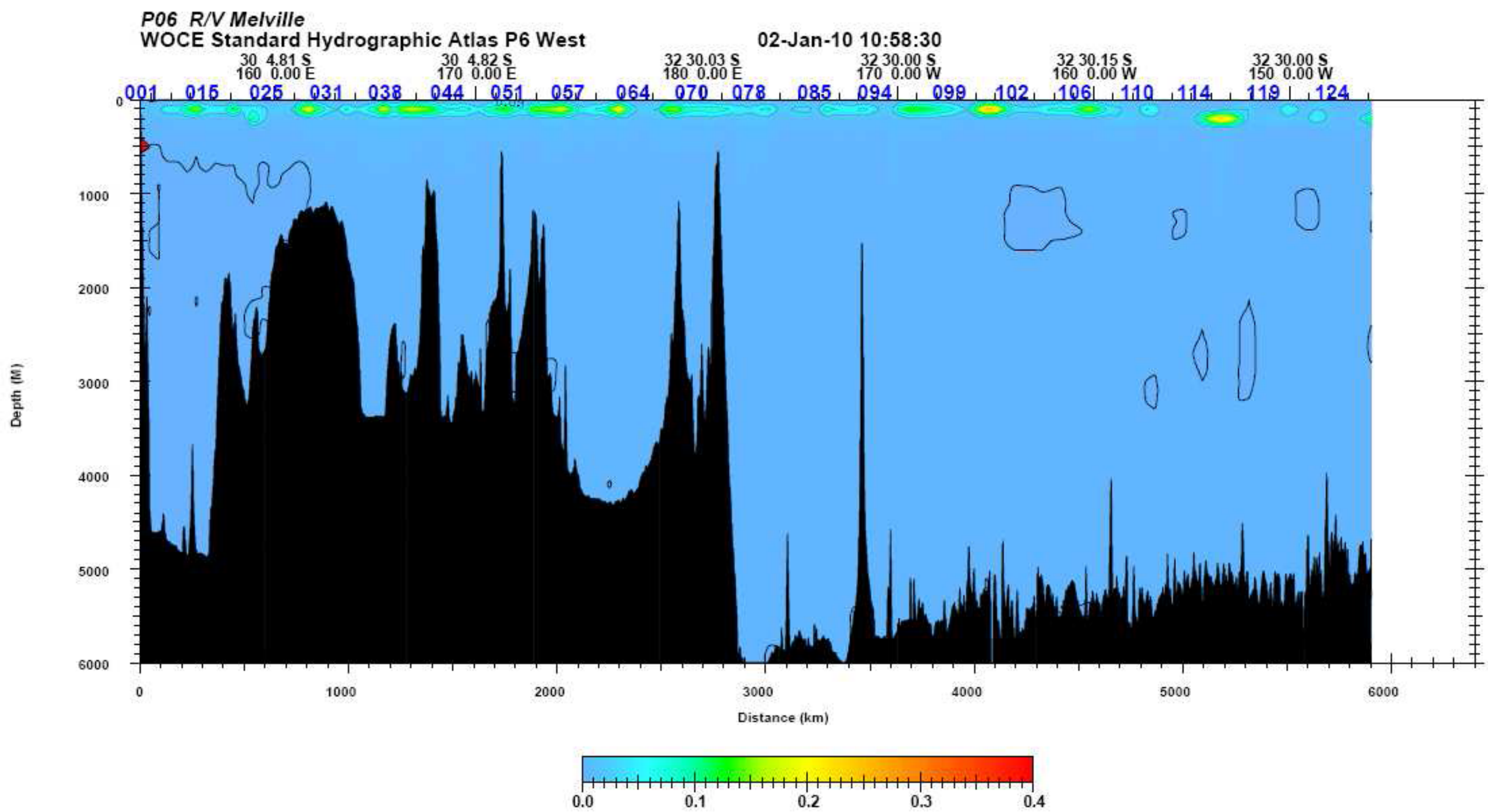
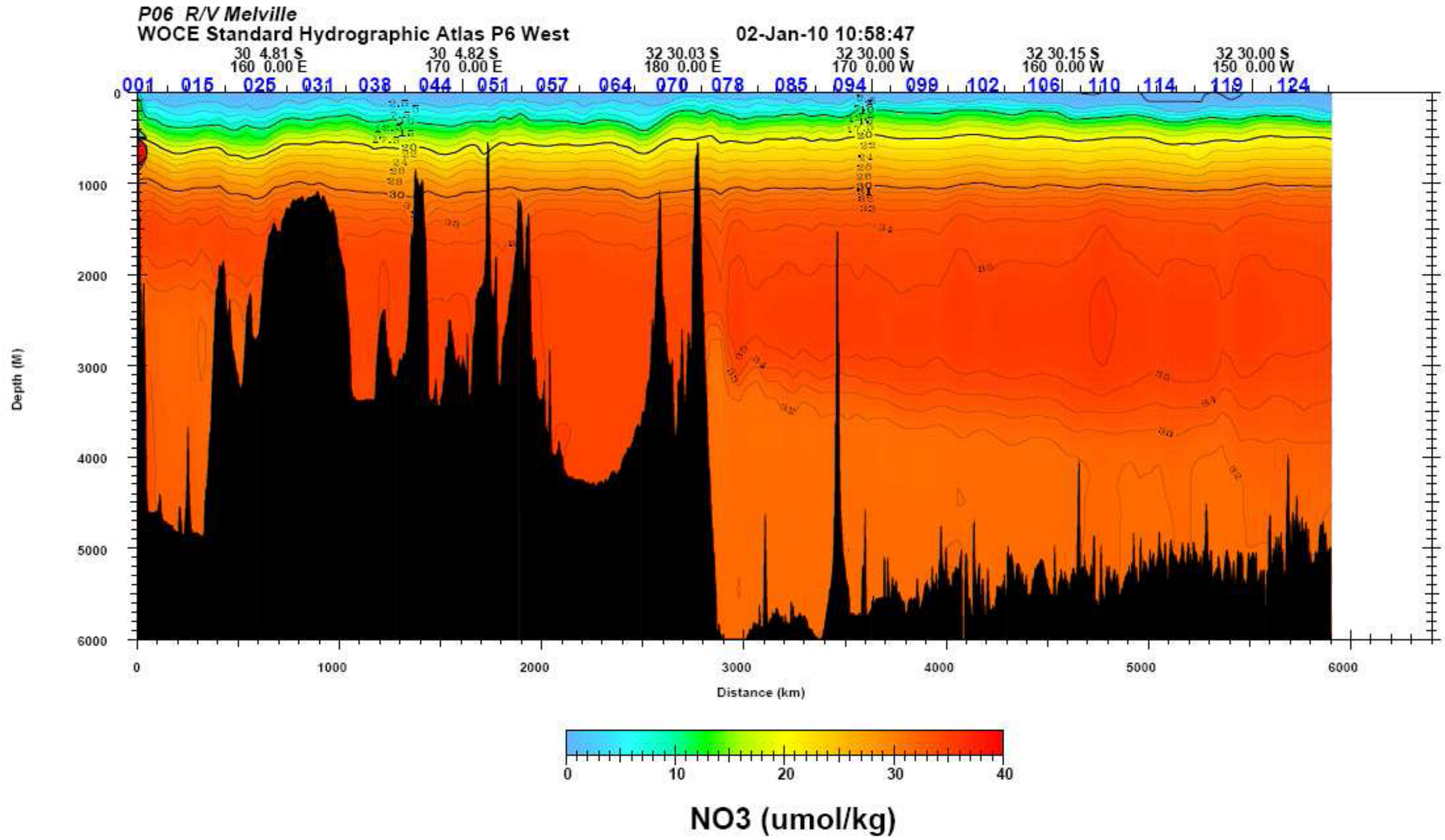
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
CFC-12 pmol/Kg



O2 (umol/kg)



NO2 (umol/kg)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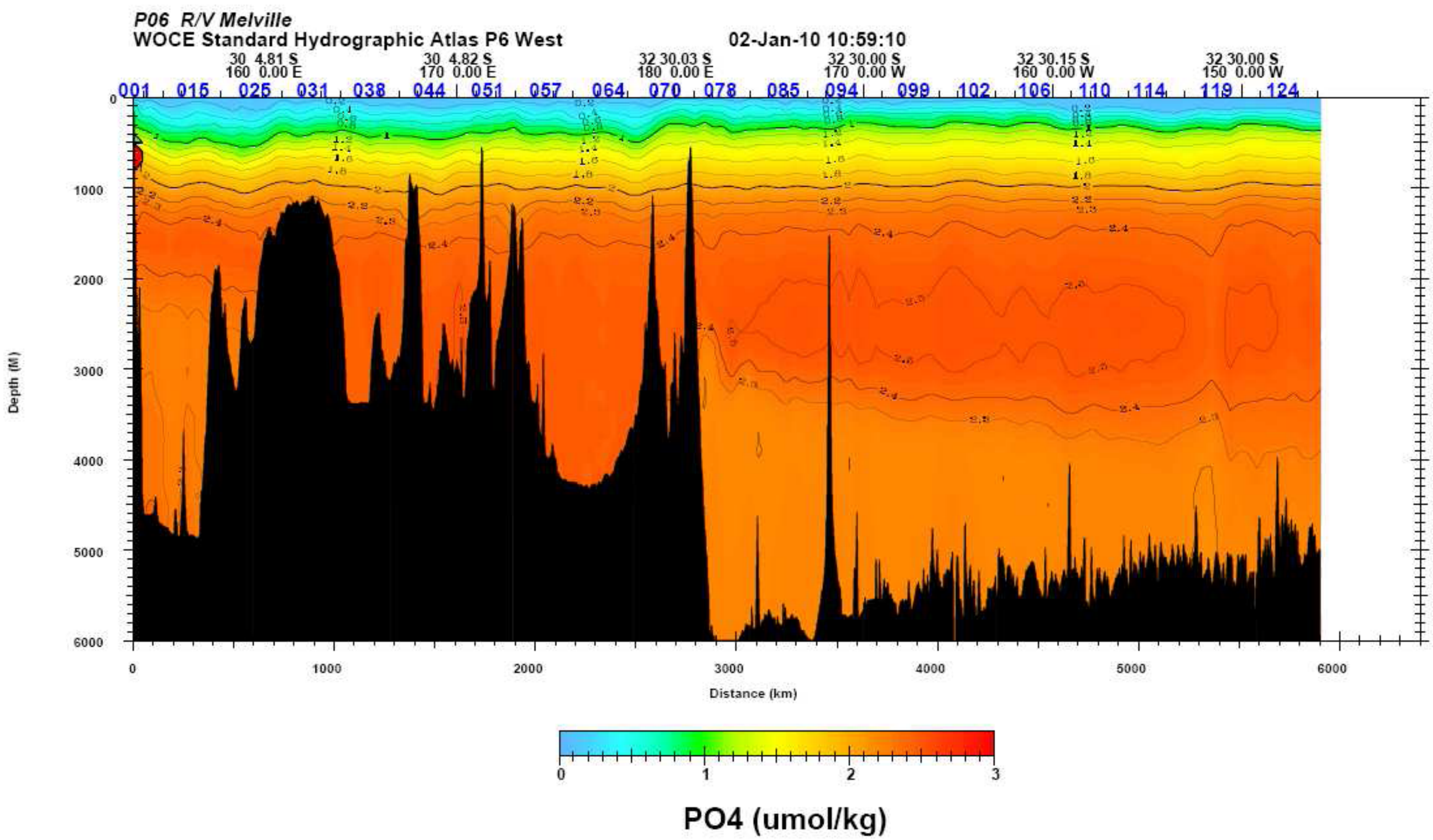
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
0 10 20 30 40
NO3 (umol/kg)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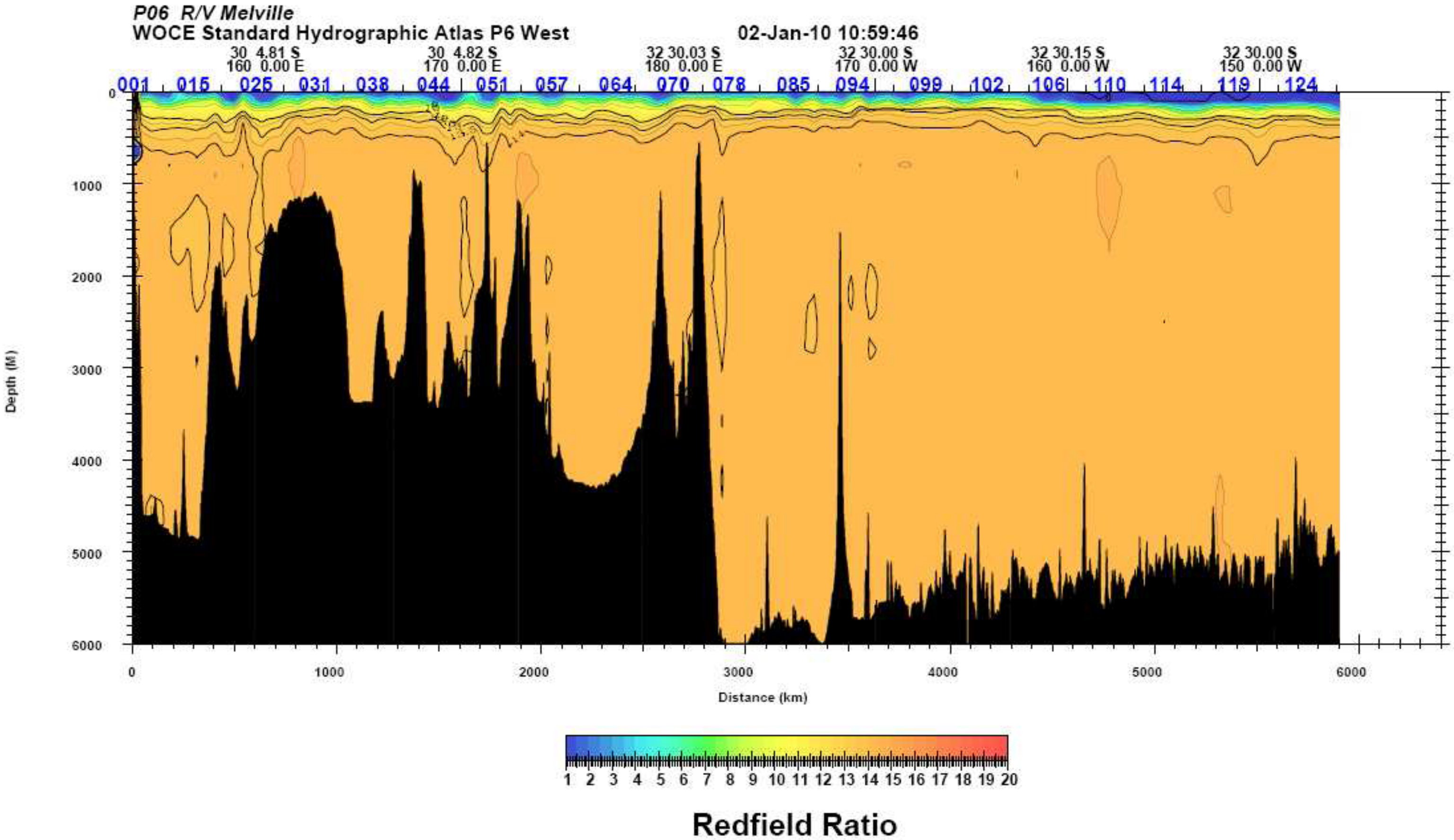
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
0 1 2 3
PO4 (umol/kg)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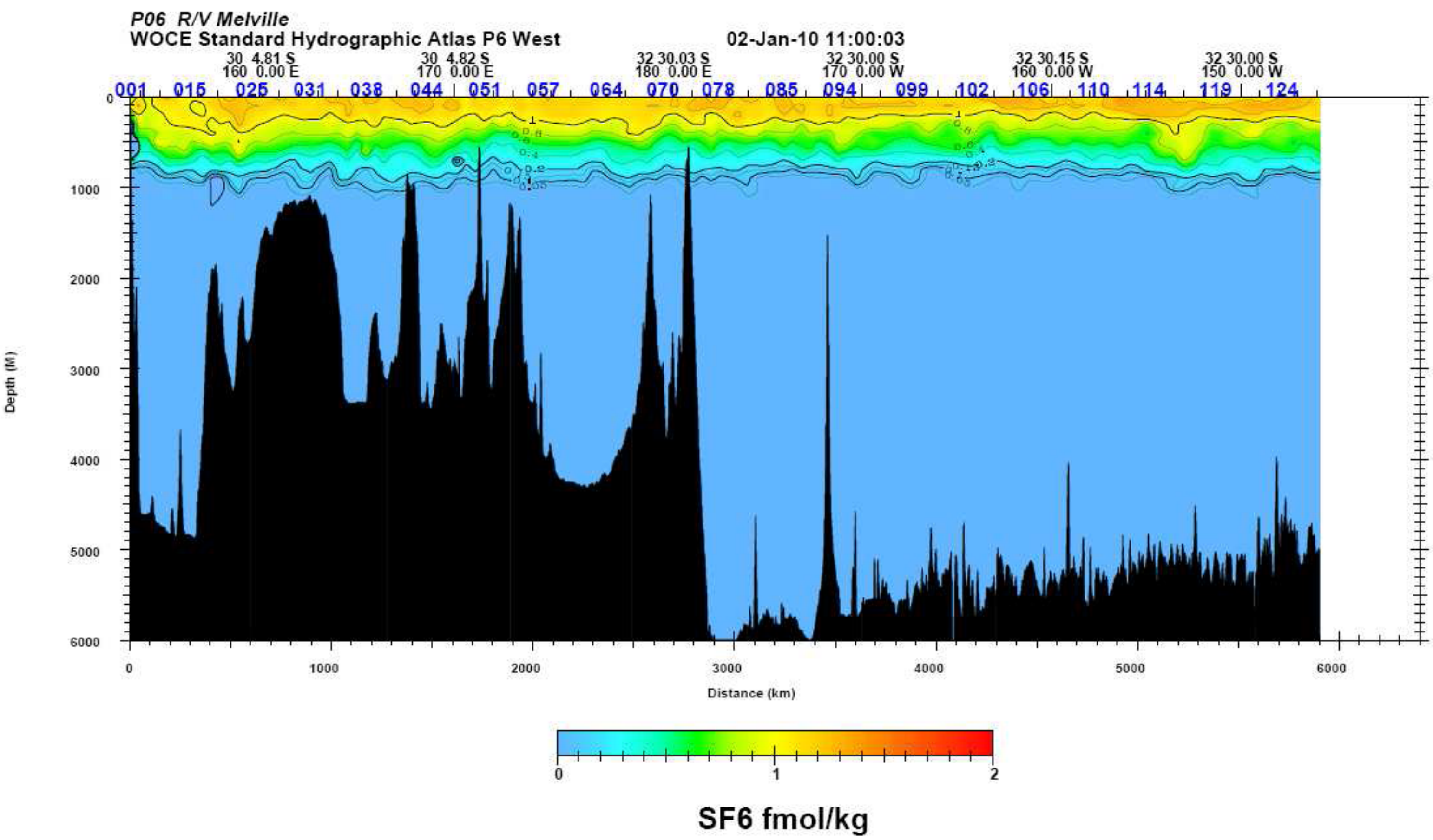
Depth (M)
Distance (km)
Redfield Ratio


P06 R/V Melville
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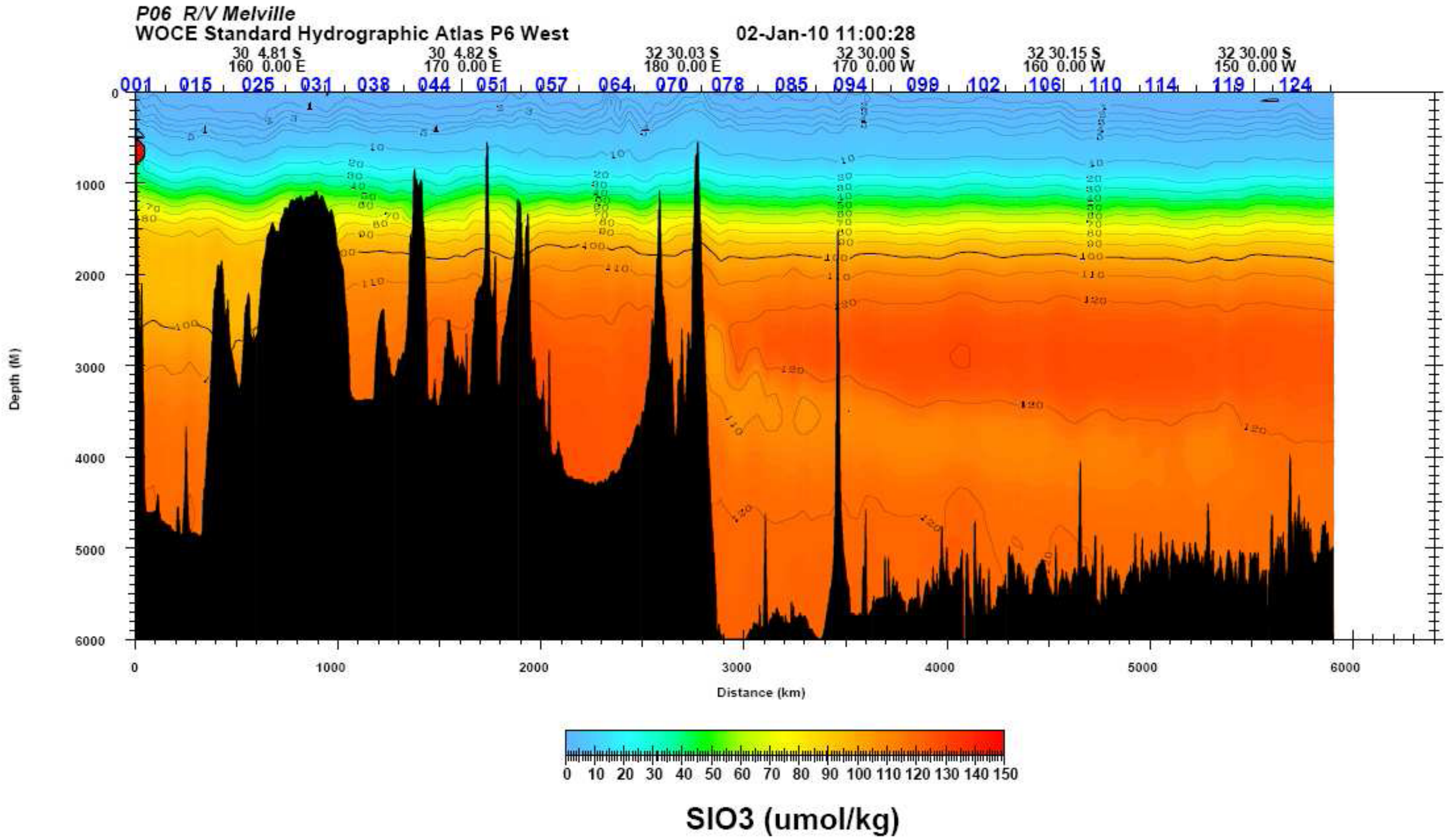
Depth (M)
Distance (km)
SF6 fmol/kg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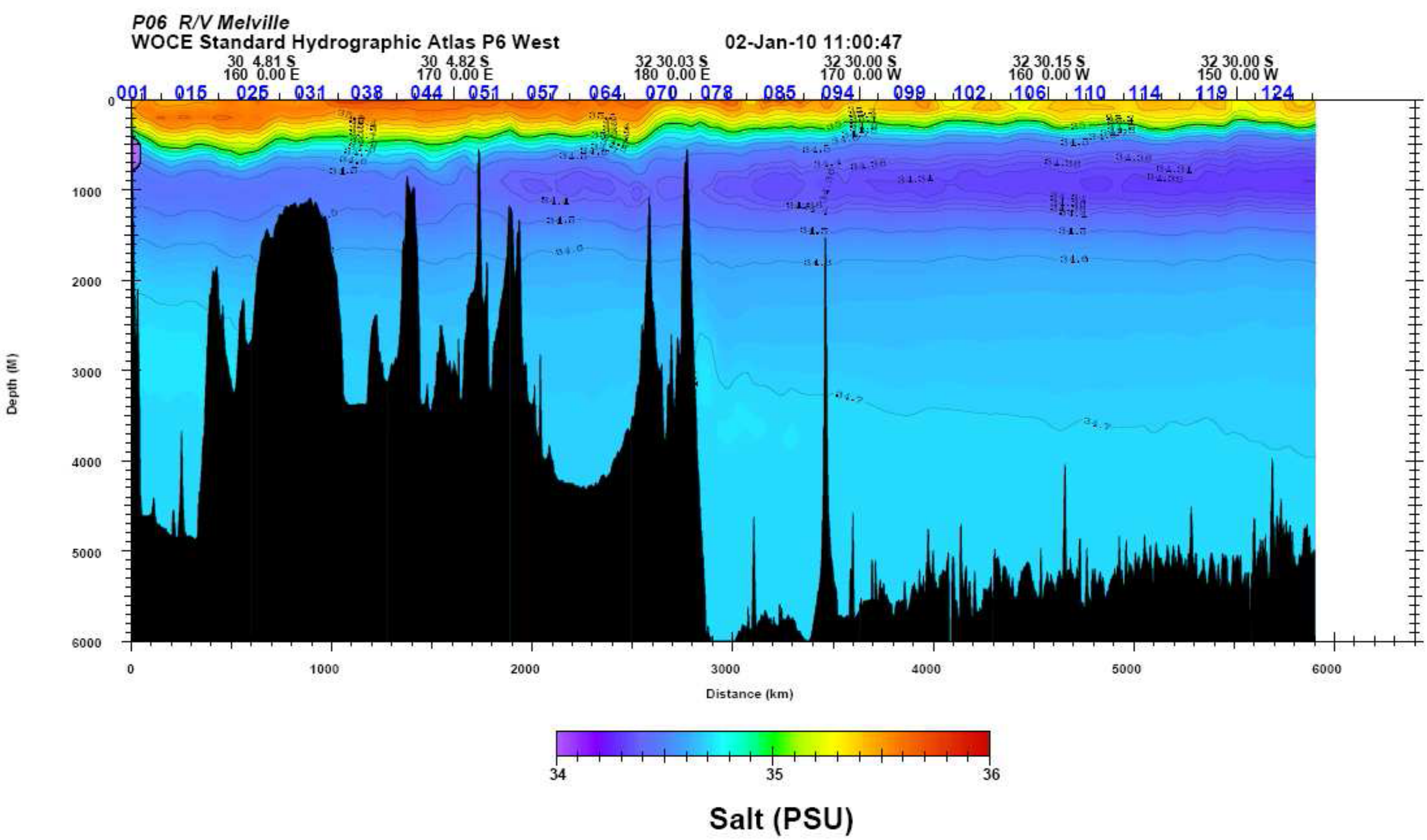
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
SIO3 (umol/kg)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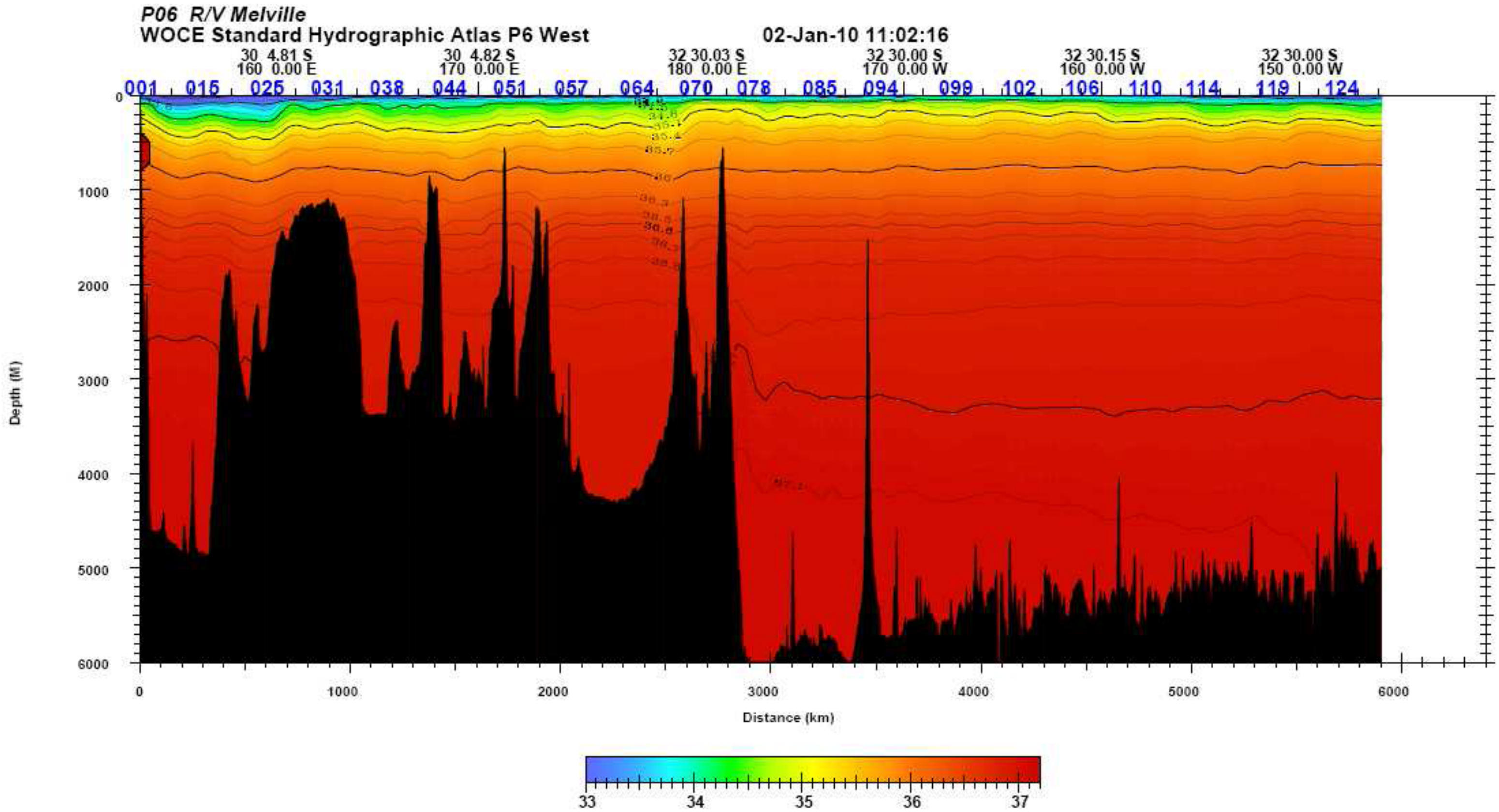
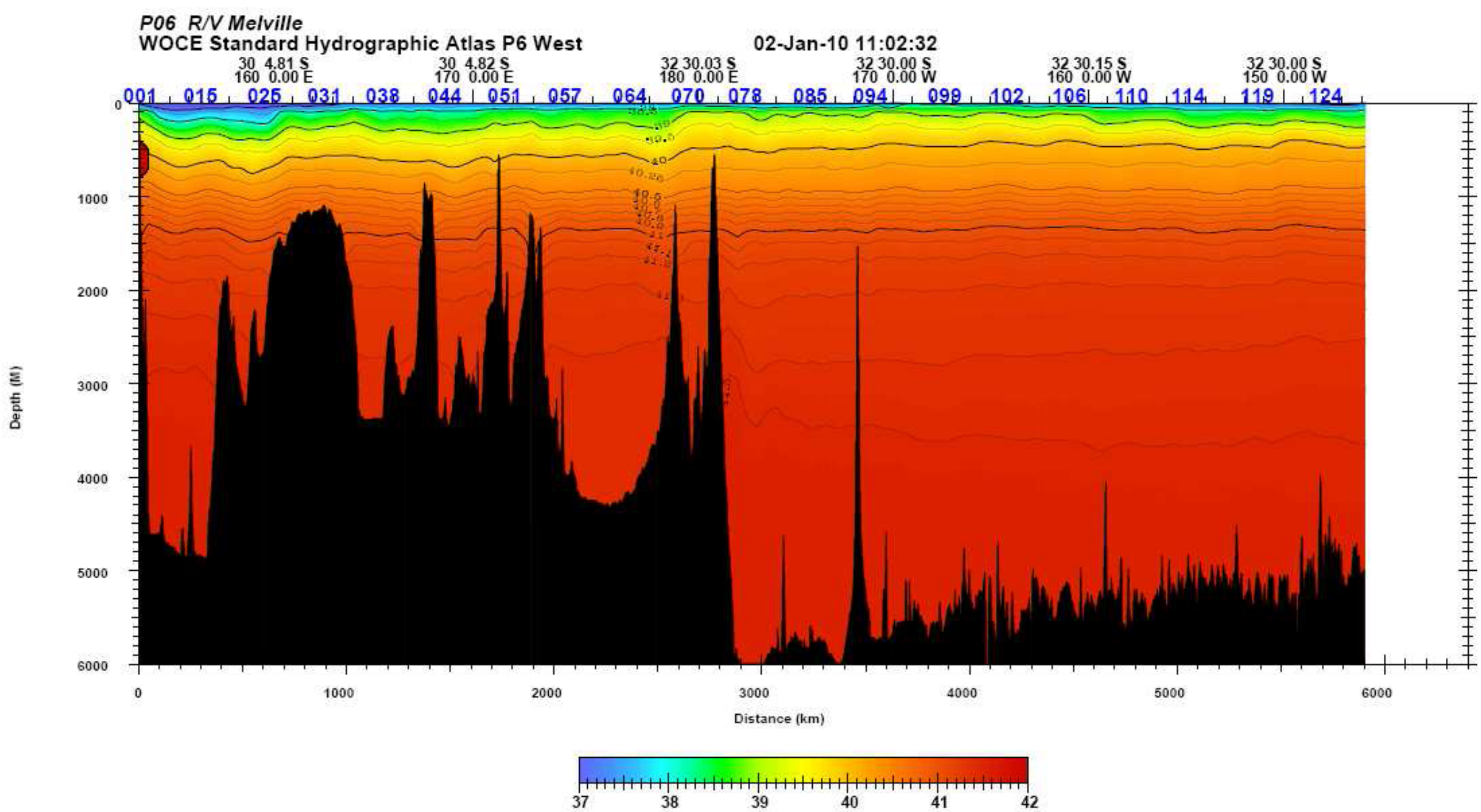
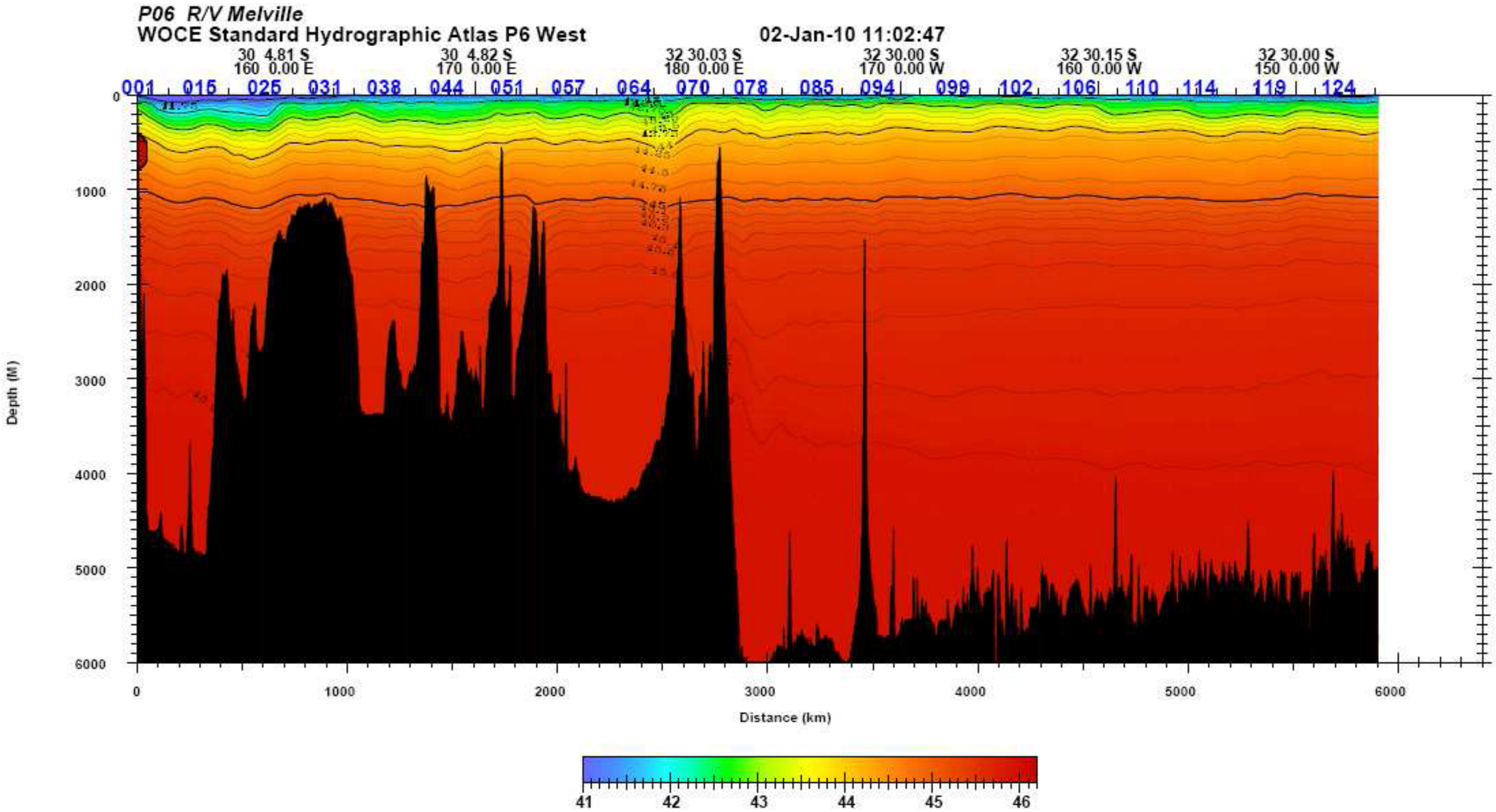
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
34 35 36
Salt (PSU)



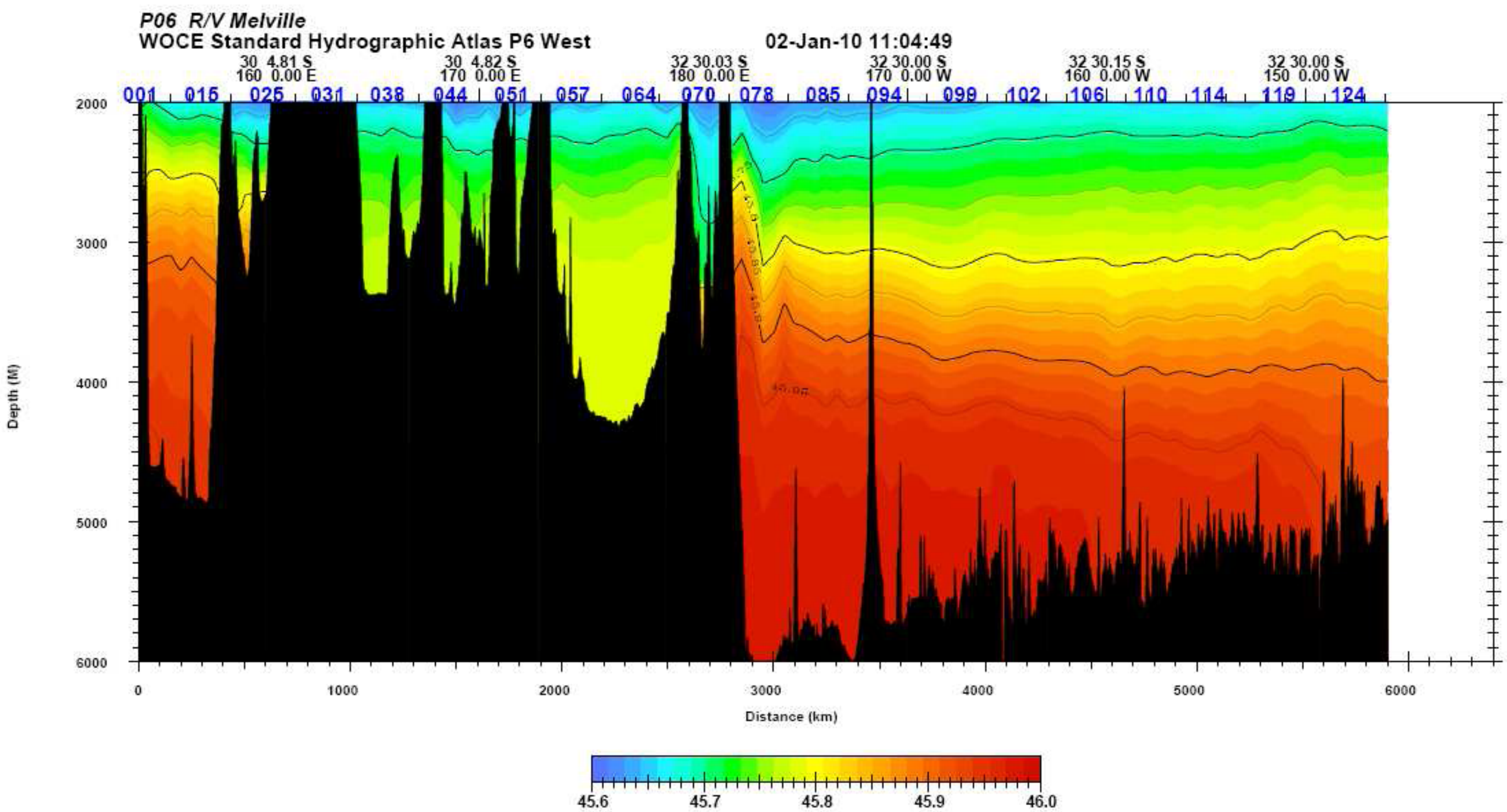
Sigma 2



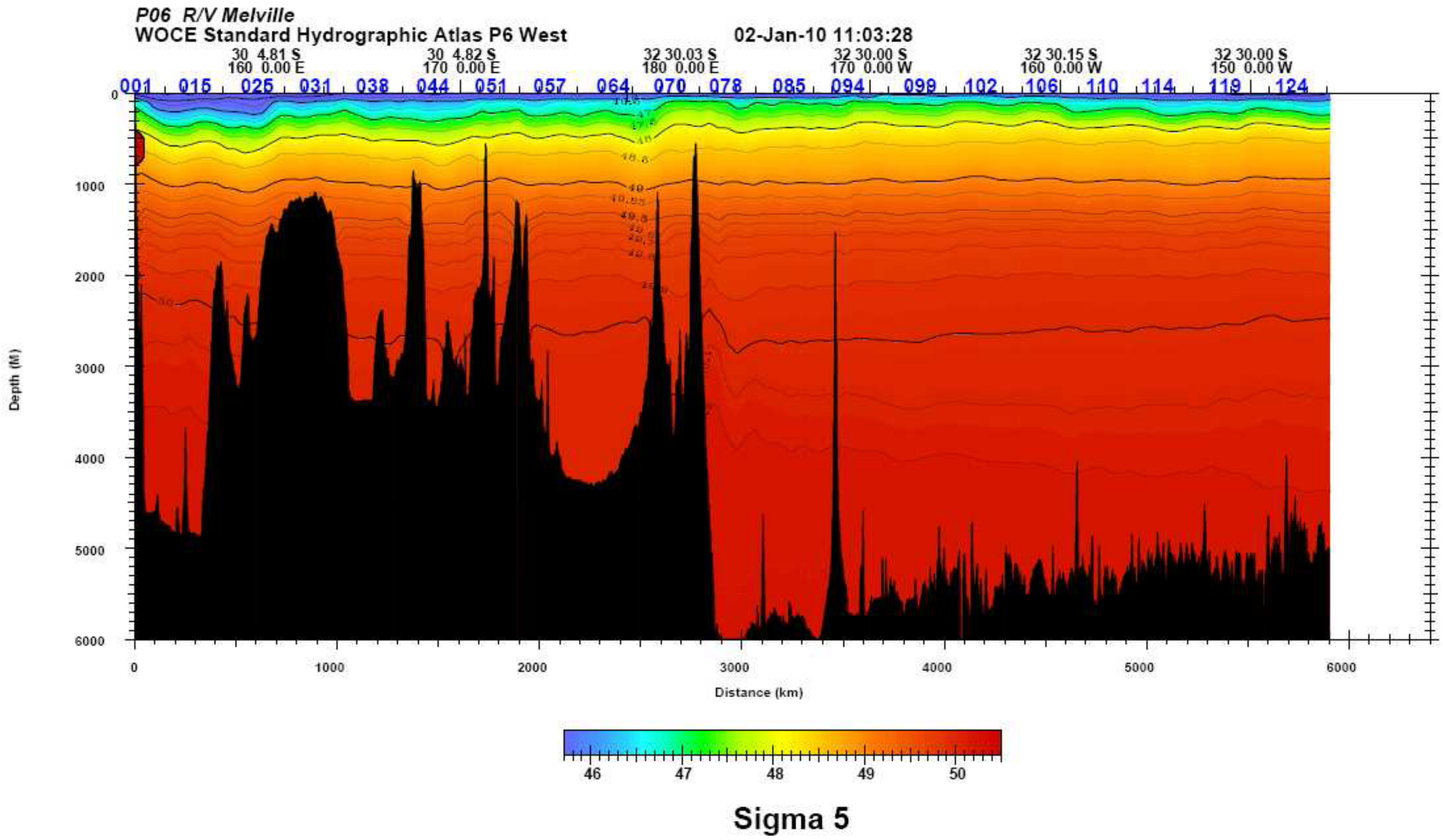
Sigma 3



Sigma 4



Sigma 4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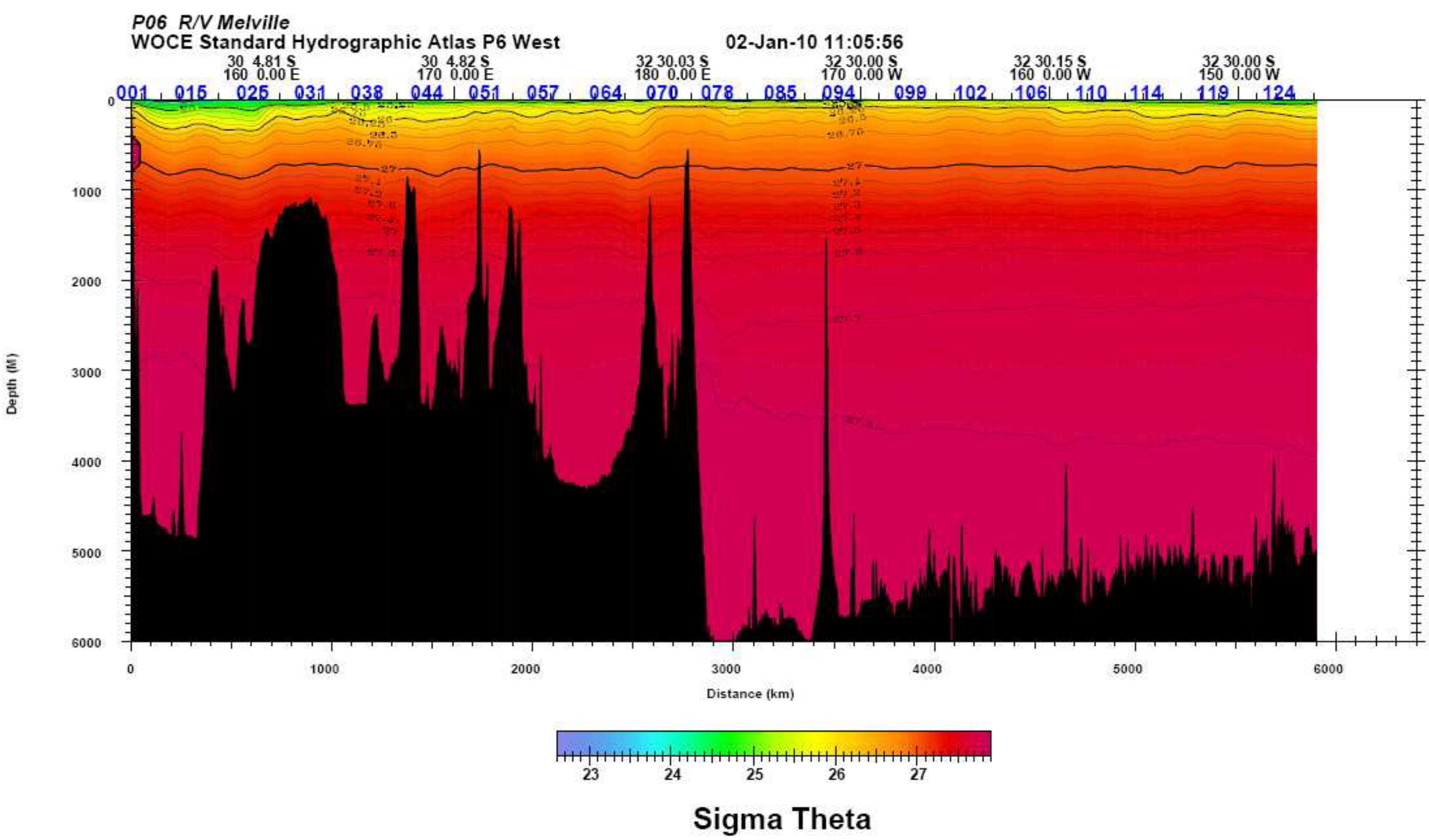
30 4.82 S 170 0.00 E
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
46 47 48 49 50
Sigma 5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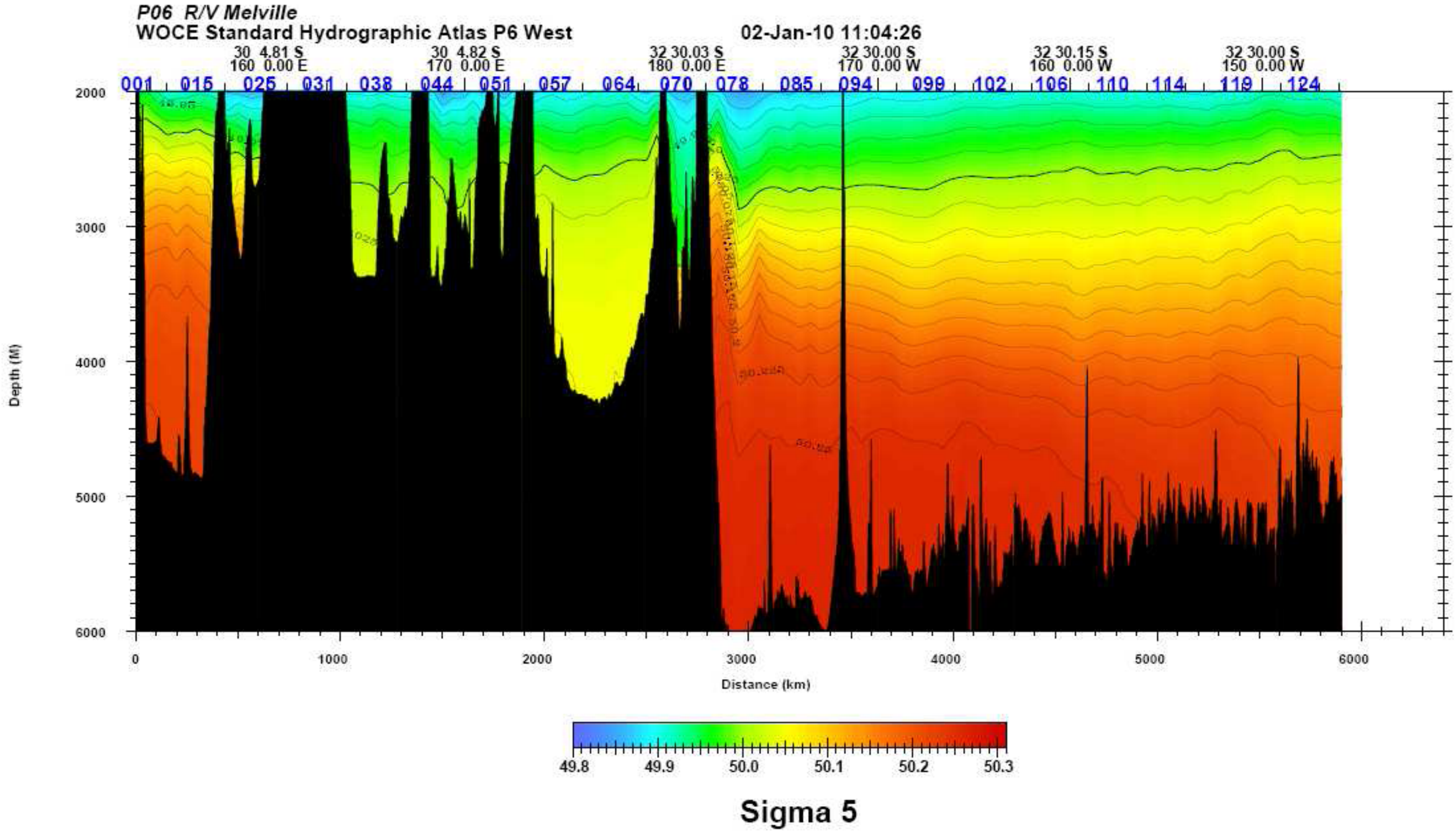
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
23 24 25 26 27
Sigma Theta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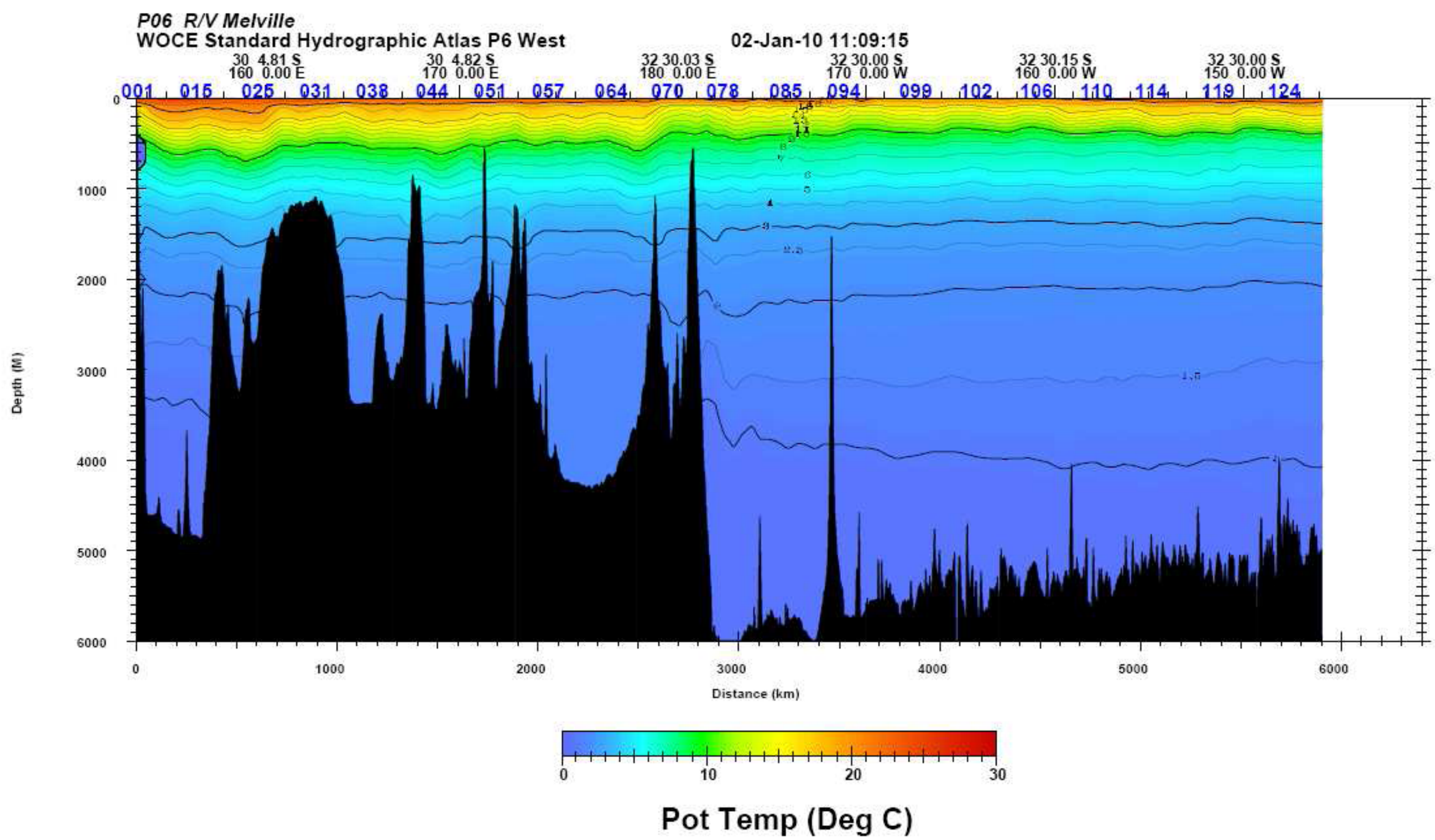
Depth (M)
Distance (km)
Sigma 5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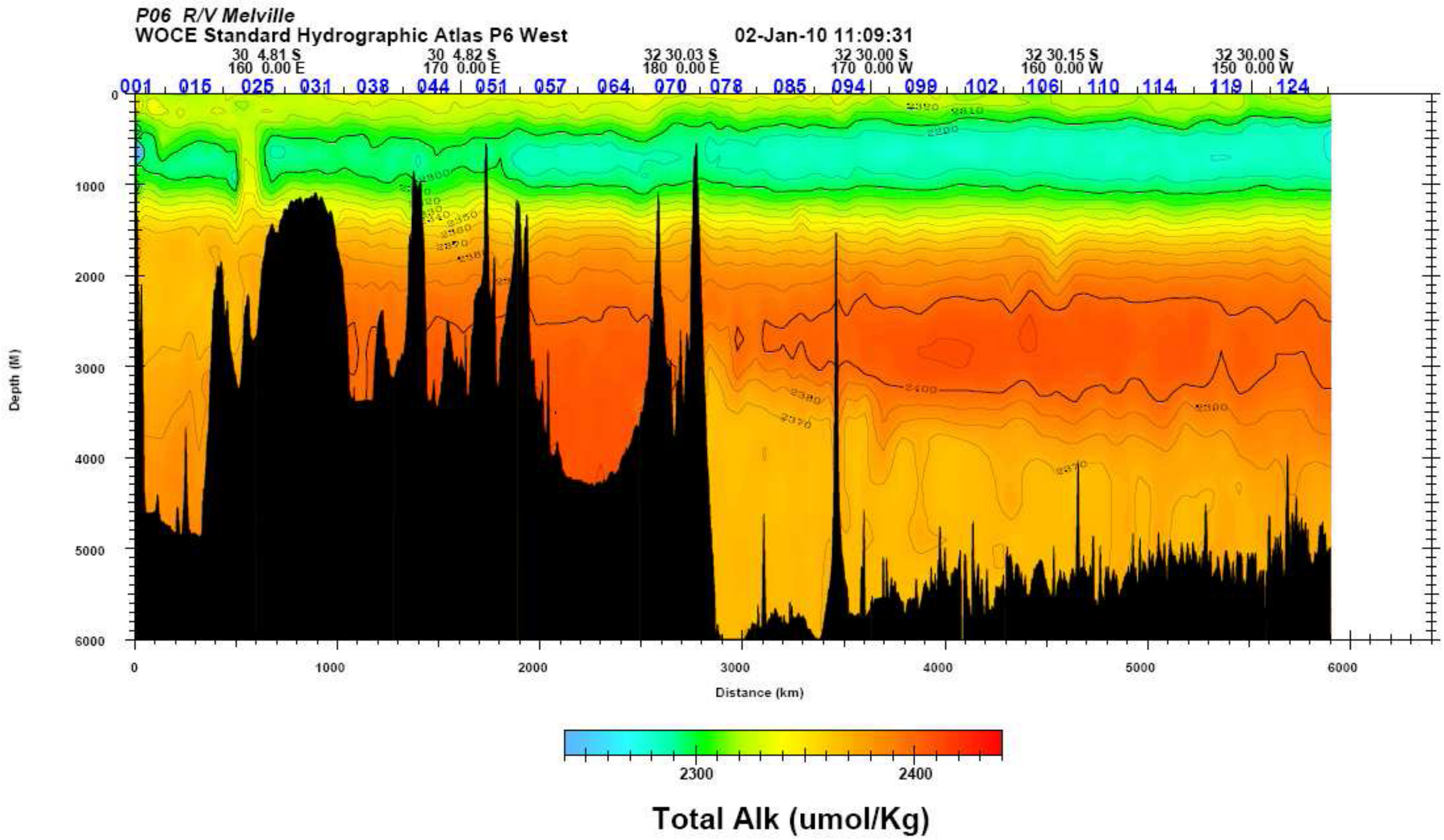
Depth (M)
Distance (km)
Pot Temp (Deg C)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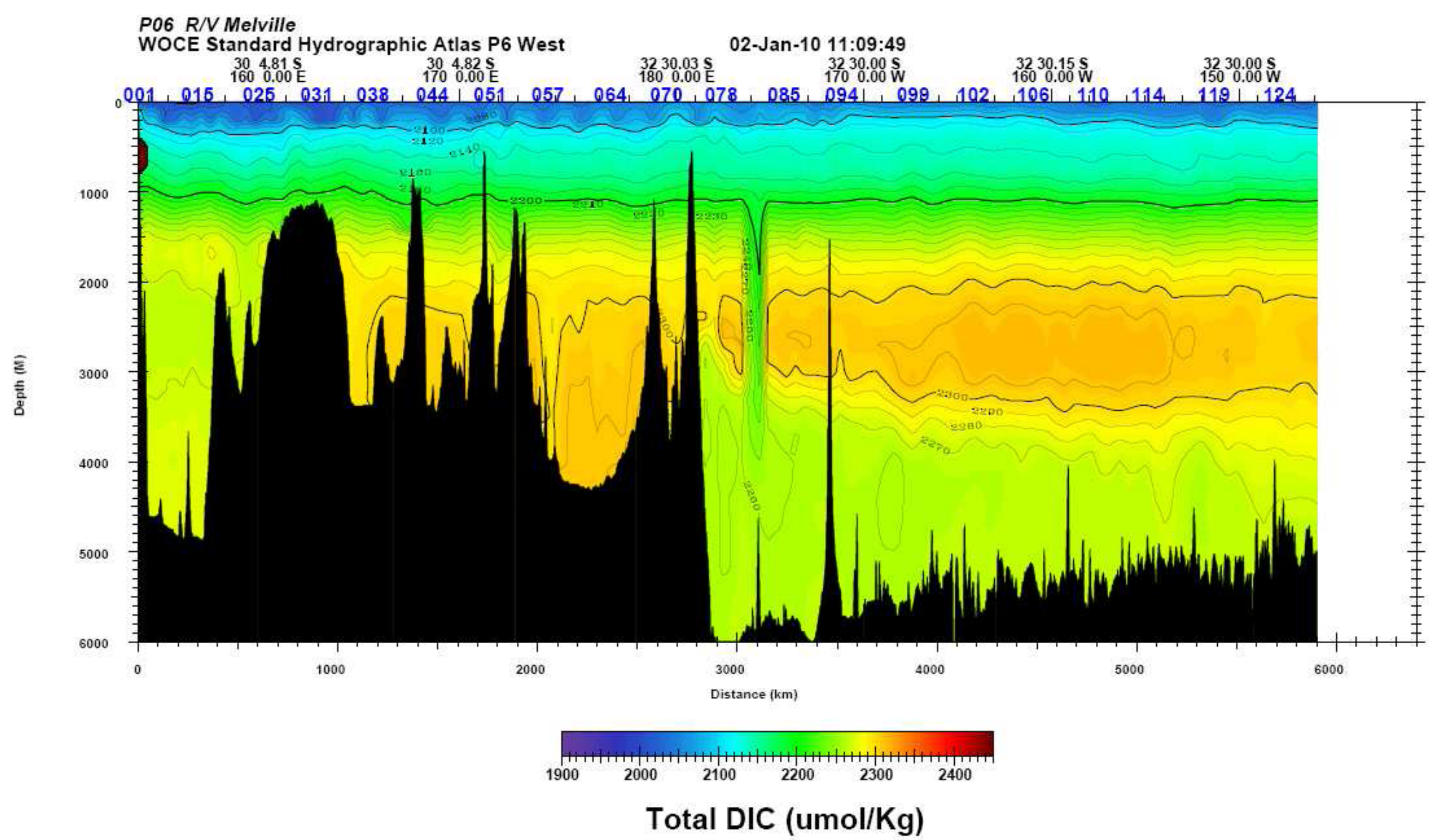
30 4.82 S 170 0.00 E
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
Depth (M)
Distance (km)
Total Alk (umol/Kg)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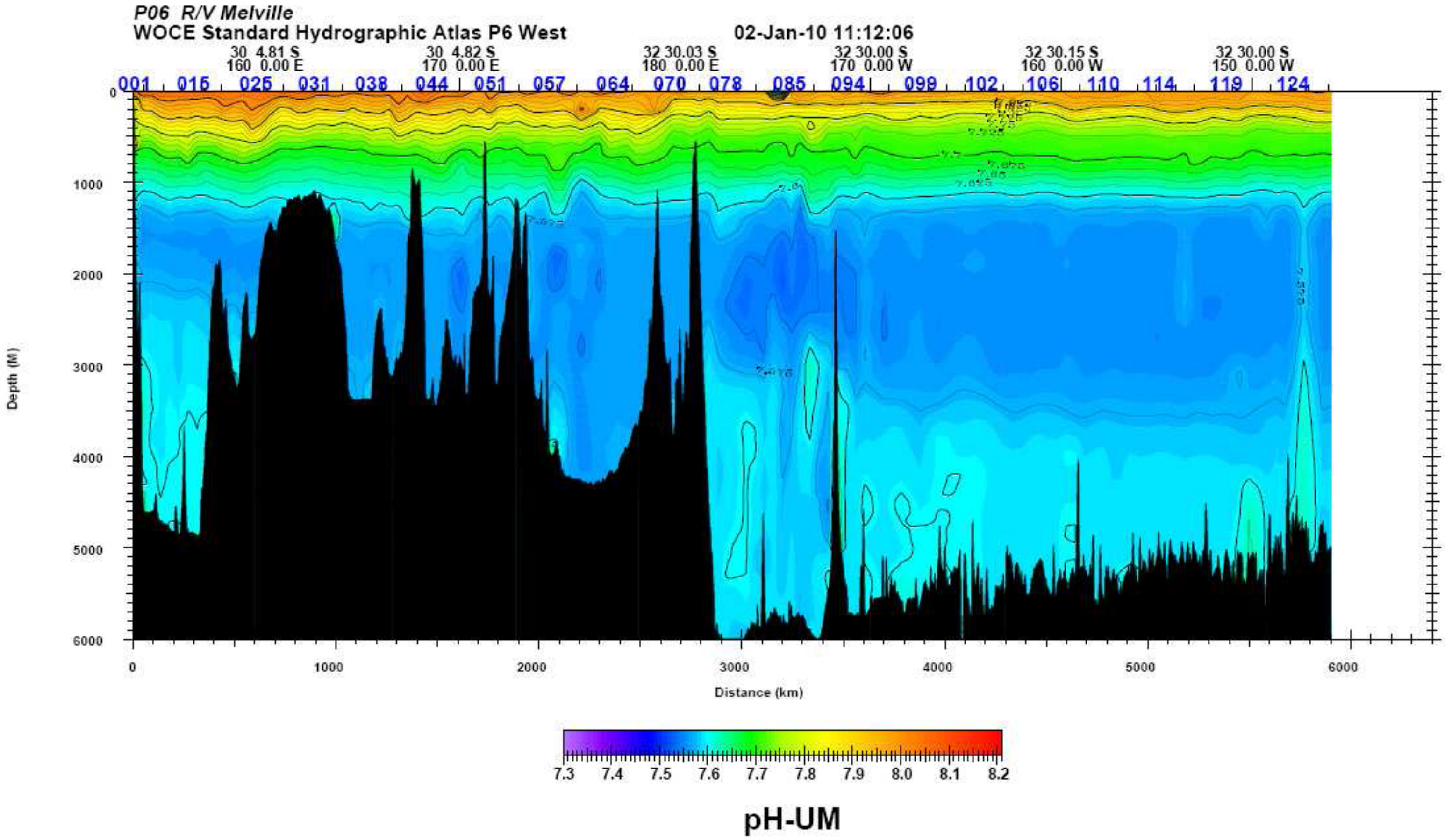
32 30.03 S 180 0.00 E
32 30.00 S 170 0.00 W
32 30.15 S 160 0.00 W
32 30.00 S 150 0.00 W
Depth (M)
Distance (km)
Total DIC (umol/Kg)



P06 R/V Melville
WOCE Standard Hydrographic Atlas P6 West
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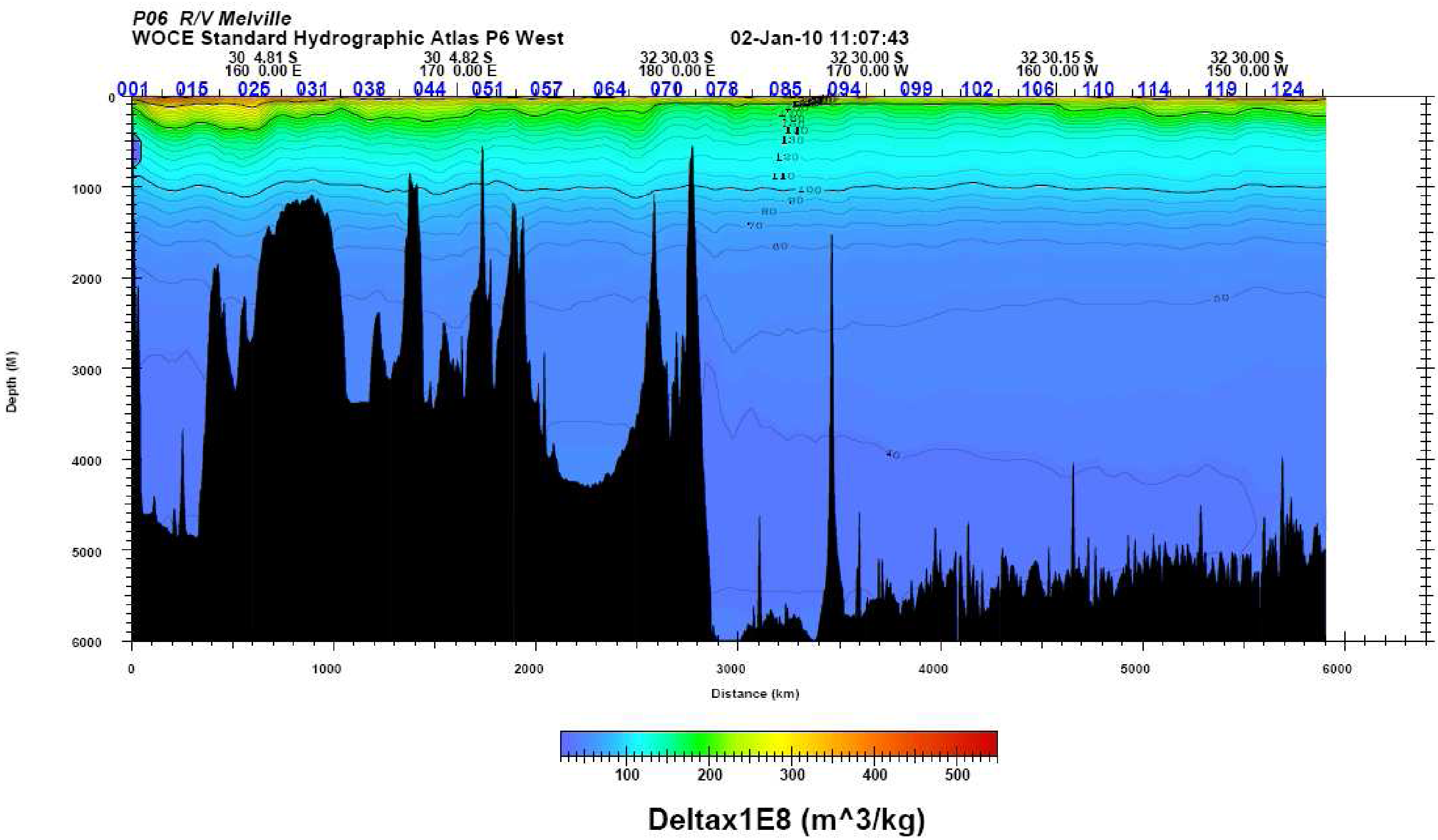
30 4.82 S
170 0.00 E
32 30.03 S
180 0.00 E
32 30.00 S
170 0.00 W
32 30.15 S
160 0.00 W
32 30.00 S
150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.2
pH-UM



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30 4.82 S
170 0.00 E
32 30.03 S
180 0.00 E
32 30.00 S
170 0.00 W
32 30.15 S
160 0.00 W
32 30.00 S
150 0.00 W
001 015 025 031 038 044 051 057 064 070 078 085 094 099 102 106 110 114 119 124
Depth (M)
Distance (km)
100 200 300 400 500
Deltax1E8 (m^3/kg)

Appendix E

At Sea – Week 1:

Our task was to carry out between 134 and 151 CTD/rosette stations. The 134 locations were designed to keep the maximum station spacing to no more than 30 nm. The 151 included these, as well as 17 'extra' stations over steep topography which were to be performed if time allowed, to limit the number jumps in depth between stations of more than 1000 m.

- The CTD (deployed amidships from the starboard A-frame) and other electronics mounted on the rosette frame provided measurements of pressure, temperature, conductivity (salinity), and dissolved oxygen, plus there were light transmission and fluorometric sensors.
- The lowered Acoustic Doppler Current Profiler measured the velocity relative to the rosette, from which the absolute velocities can be derived.
- Water samples from the 36 10 liter bottles on the rosette were analyzed on board for salinity, dissolved oxygen, nutrients (nitrate, nitrite, phosphate, and silicate), CFCs (F11, F12), SF6, dissolved inorganic carbon, total alkalinity, and pH. Samples for shore analysis were collected for dissolved organic carbon, total dissolved nitrogen, the carbon isotopes 13C & 14C, tritium, dissolved helium, and helium3.
- Our ADCP tech also collected samples to study DNA/RNA.
- The pH/Talk group collected samples to measure density. The density samples were taken at five stations during the cruise, sampling the full cast (Stations 8, 38, 58, 100, 122). The samples were drawn into 125 mL HDPE bottles rinsing twice before filling. These samples will be analyzed for density using an Anton- Parr vibrating densitometer and re-analyzed for salinity (to account for any evaporation) back in Miami.
- We also collected 125 ml samples for Dr. Mark Altabet of U. of Massachusetts Dartmouth to measure the N and O isotopic composition of nitrate at 20 stations on leg 1. The bottles were pre-prepared and labeled. No rinsing was required. Most of the stations on which these samples were collected were collocated with stations at which helium and/or tritium were also measured , and the cross-reference between the two sets of samples was kept for Dr. Altabet.
- We had a group with us measuring colored dissolved organic material (CDOM), bacteria, chlorophyll and particulate organic matter and performing their own spectroradiometer casts to study the effects of CDOM on the underwater light environment. These casts were performed once a day at approximate local noon.
- Our science party also included a 4-person team measuring aluminum and iron (from separate "trace metal" casts with their own rosette and synthetic cable deployed on a Kevlar coated cable using the stern A-frame).
- The aerosols group was unable to join us due to final schedule change.
- We ran a continuously pumped surface seawater system that measured temperature, salinity, dissolved oxygen, fluorescence.
- The underway pCO_2 system failed early on in leg 1.
- Other measurements included velocity from the ship's Doppler current profilers, data from a suite of meteorological parameters, multibeam bathymetry, and navigation data.
- We deployed 2 APEX floats and 6 Iridium floats at predetermined locations along the section for Dr. Ann Thresher (CSIRO).

We set out in good weather and high spirits on the morning of the 21st. Taking 5 hours to get out into the open sea followed by a steam south to approximately 30°S. It was decided that rather than perform our test station with inexperienced watch standers in the dark, to move on to the location of the first station, and perform the test in the same place. The rosette first went into the water at 03:42 in November 22nd UTC (15:42 local). This test station was a learning experience in terms of deployment and recovery for the student watch standers, but had to be aborted when signal to the package was lost almost immediately upon entry into the water. No bottles were fired. Retermination of the rosette was required.

The package went into the water again and performed well. In less than 100m of water, all bottles were fired. Bottles 1, 7, 13, 19, 25, and 31 were used to test water volume usage for a non-carbon cast, bottles 2, 8, 14, 20, 26 and 32 were used to represent a full carbon cast. We determined that we would be able to accommodate everyone's water needs. We labeled the result, station 1.

At station 2 both the CTD cast and the test of the trace metal cast went well. The first non-test trace metal cast (cast 1) was performed successfully at the beginning of station 3, however, for the CTD group station 3 became an odyssey of failures. As the stations at the western end of P6 are so close together (< 10 km apart) there seemed little to be gained by moving on to deeper stations until the cause of the issues with rosette were determined and corrected.

1. Station 3, cast 2 – aborted due to unstable acquisition that failed at 218 m, during recovery acquisition returned from 120 m to the surface. Reterminated the sea cable.
2. Station 3, cast 3 – Bridge reported seeing something fall of during deployment. Aborted when acquisition failed at 400 m. Two damaged bottles were the likely cause of the Bridge report. Prime suspects of power loss, the transmissometer and fluorometer, were removed.
3. Station 3, cast 4 – Aborted when acquisition became unstable at 250 m. This time it was noted that the error occurred every 5 seconds – likely coincident with POST delays before turning on the pumps. Upon inspection it was found that the pump cable WYE was bad.
4. Station 3, cast 5 – Fluorometer and transmissometer once again included in the package. Aborted on the way back up at 570 m when CTD acquisition failed – the cause was the failure of the station 1 retermination. Reterminated again. The fired bottles were sampled.
5. Station 3, cast 6 – down to 570 meters and back: successful. Casts 5 and 6 are combined to form a complete profile.

At Sea – Week 2:

The one of the main points of scientific interest in this particular transect repeat was determining the present properties of Antarctic Bottom Water (AABW) and comparing them to those found during previous occupations. For this reason we anticipated the sampling this water mass. The western side of the Pacific at this latitude is marked by steep gradients in topography beginning with a step out from the shelf into the Tasman Sea. Our first Antarctic Bottom Water was found at station 7, the first station deeper that 3000 m. The only obvious difference between the Tasman Sea bottom waters as we measured them and those seen previously occurred in the CFC’s, and that difference was striking (Table E1, Figure E1).

Table E1: Comparison of 2009 vs. 1992 mean, standard deviation, minimum and maximum values of properties in the bottom waters (>4000) in the Tasman Sea.

	Theta (°C)		**DIC (μmol kg^{-1})**		**Oxygen (μmol kg^{-1})**		**Phosphate (μmol kg^{-1})**		**CFC12 (pmol kg^{-1})**	
	2009	**1992**	**2009**	**1992**	**2009**	**1992**	**2009**	**1992**	**2009**	**1992**
Mean	0.831	0.818	2276.4	2276.5	196.5	196.7	2.31	2.31	0.014	0.003
Stdev	0.016	0.022	-1.6	-1.1	-0.5	-1.6	0.02	0.02	0.003	0.003
Min	0.800	0.779	2273.3	2274.8	195.6	195	2.28	2.25	0.009	-0.001
Max	0.879	0.892	2279.1	2278.1	197.6	204	2.35	2.34	0.020	0.012

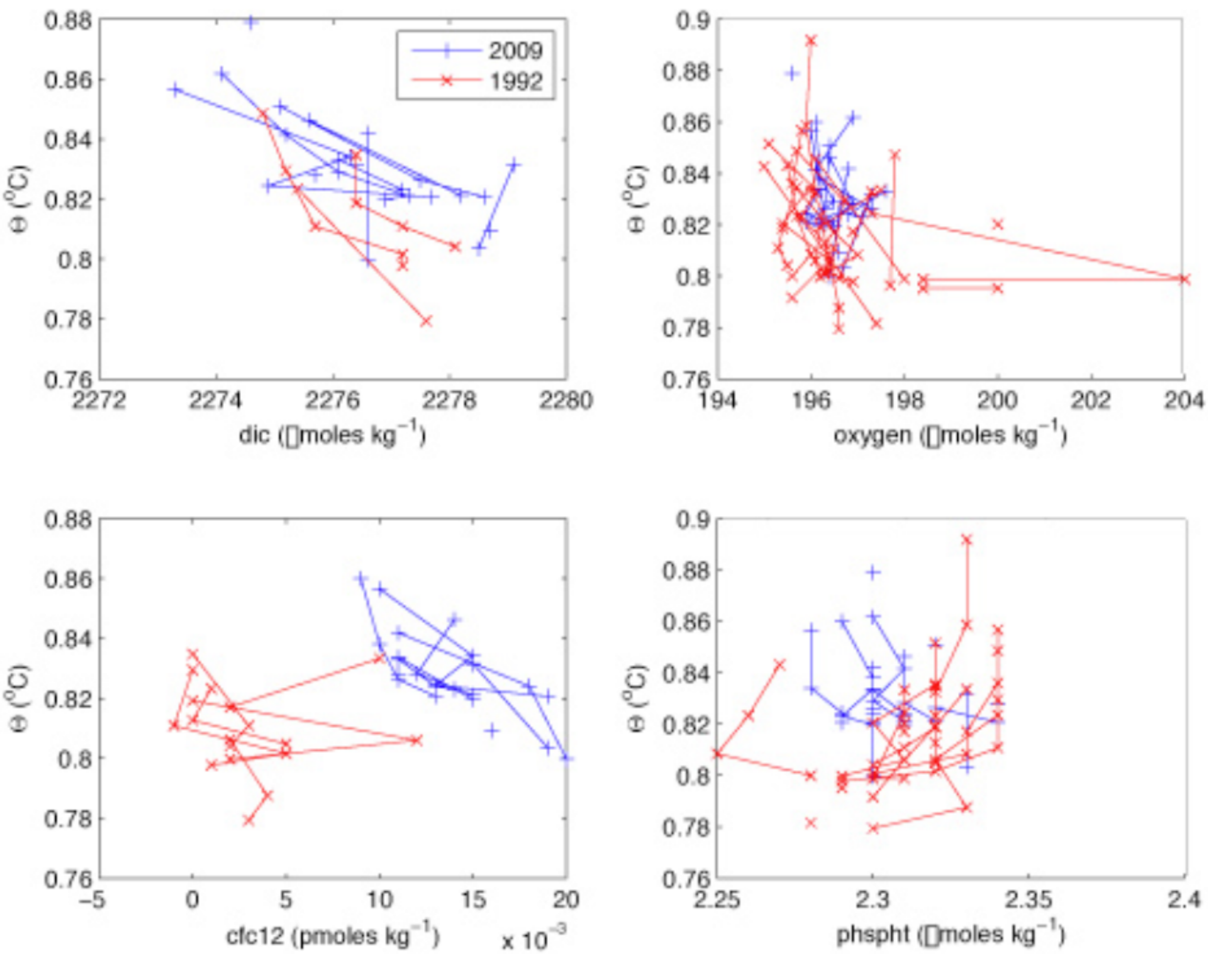

Figure E1: Comparison of 2009 and 1992 concentrations of DIC, oxygen, CFC12 and phosphate in the bottom waters (> 4000 dbar) in the Tasman Sea.

We also anticipated crossing the East Australia Current (EAC), the southward flowing, western boundary current of the South Pacific subtropical gyre. The EAC is a highly variable current with strong recirculations. We were at first somewhat confused by the strong northward and then strongly eastward currents measured by the LADCP (Figure E2). However, looking at satellite imagery, Scott Grant realized that we were clipping the northern edge of a large semi-permanent eddy (Figure E3) seen in this region previously (Ridgeway et al., 2003)

Nearing the eastern side of the Tasman Sea (past 160°E) the winds picked up and we experienced enough swell that one of optic casts had to be aborted. Nevertheless, we have had amazingly fair weather and dazzling clear, glassy seas for much of this cruise; the clouds which often ringed the horizons in the morning created gorgeous sunrises, tending to break up as the day went on.

In the early days of the cruise, the only other disruption we've had occurred on the night of the Nov. 30th, when the DIC van lost power, and therefore, temperature control. The ship's engineers soon had the DIC group back in business. As we crossed the Lord Howe Rise into the New Caledonia Trough, the DIC team immediately noticed a change in water mass characteristics, born out in other properties (e.g. oxygen and nutrients) as well, and also seen in 1992 (Figure E4). This same change was visible in the earlier data.

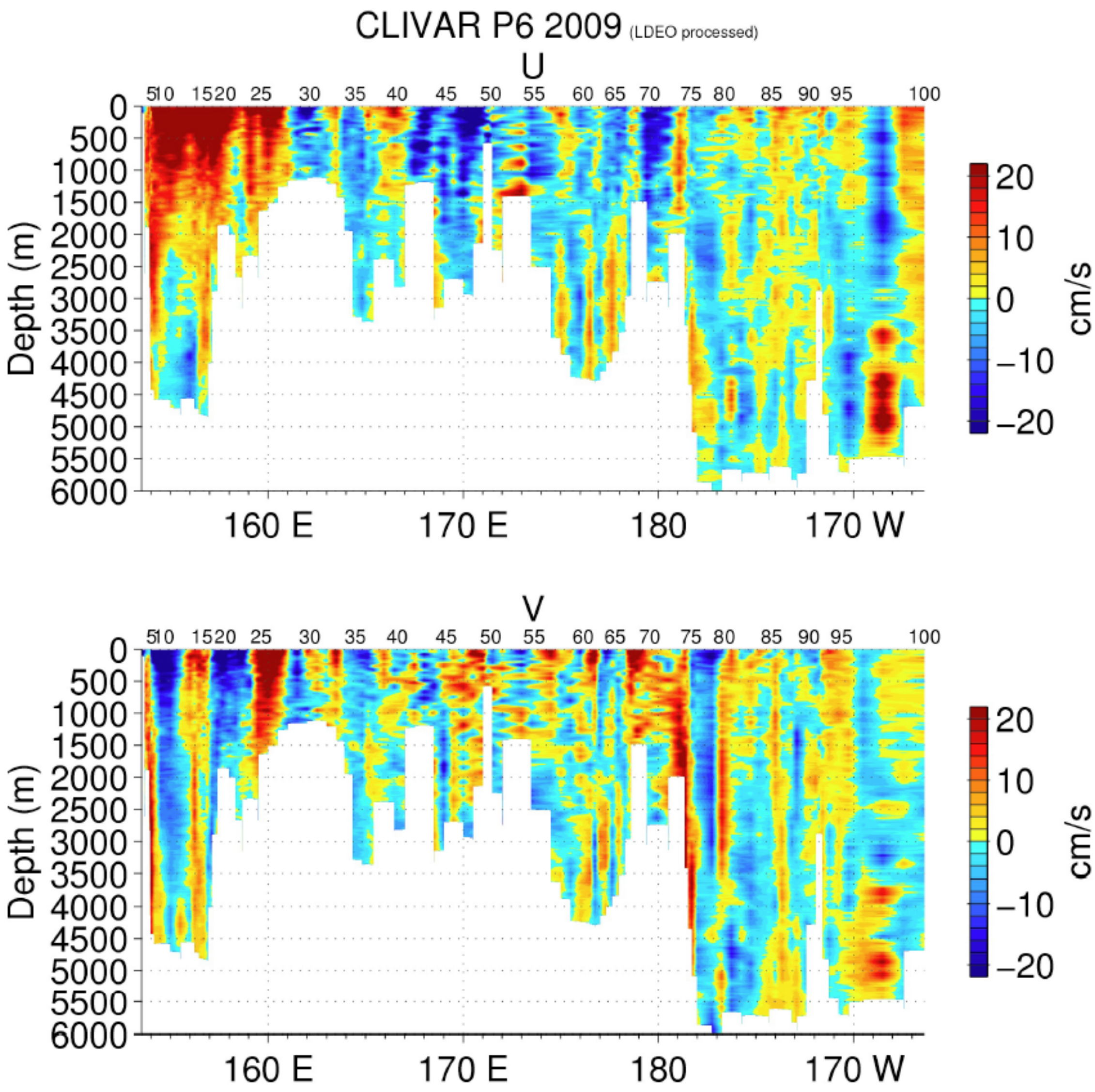

Figure E2: LADCP velocities for the 100 P6 stations (S. Grant). The other interesting features to notice in these figures are the alternating zonal velocities above the ridge on the western side of the Fiji Basin (between about station 52 and station 57).

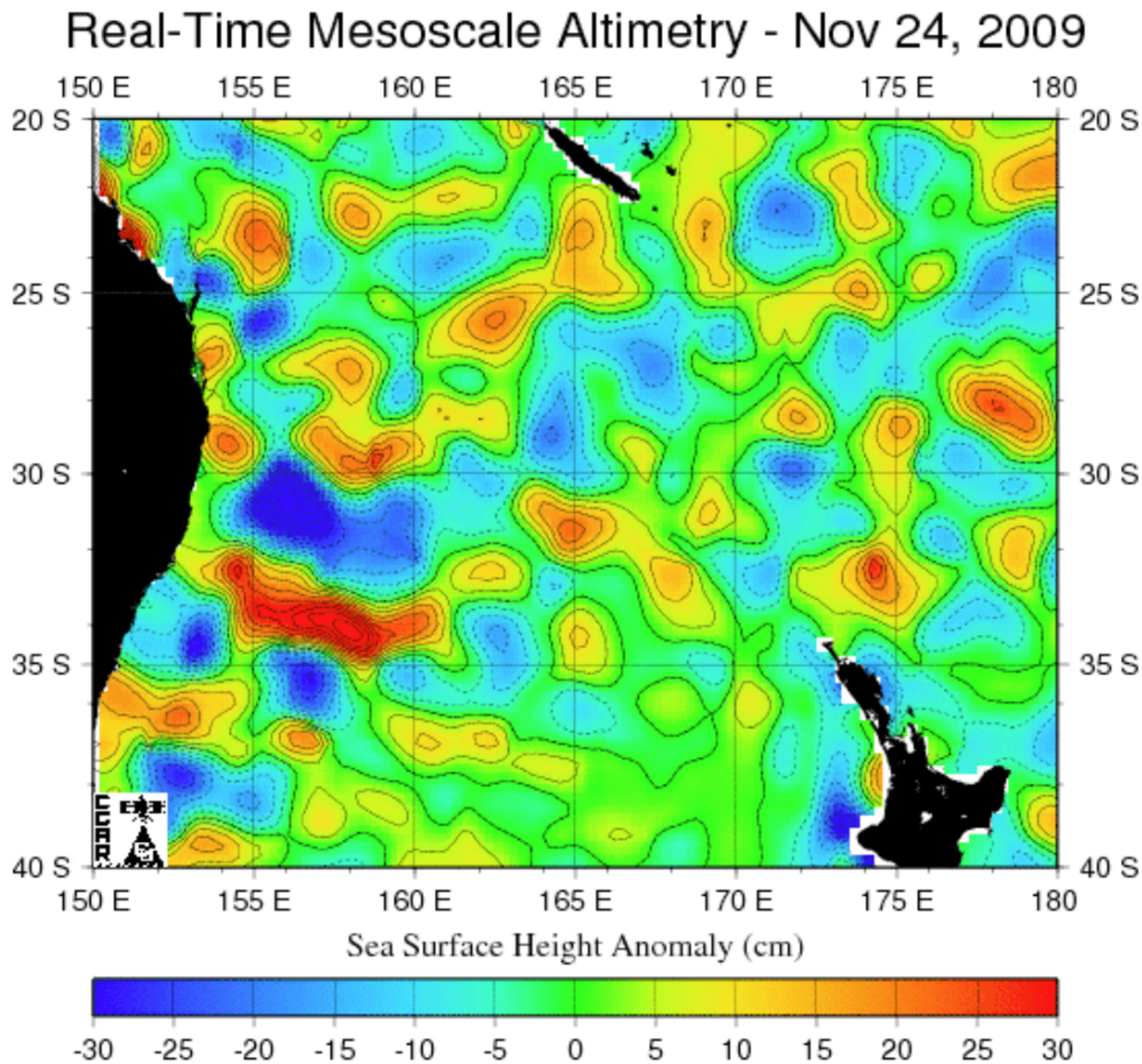

Figure E3: Real-time altimetry of SSH during one day early in the P6 occupation indicating the large eddy near 30S.

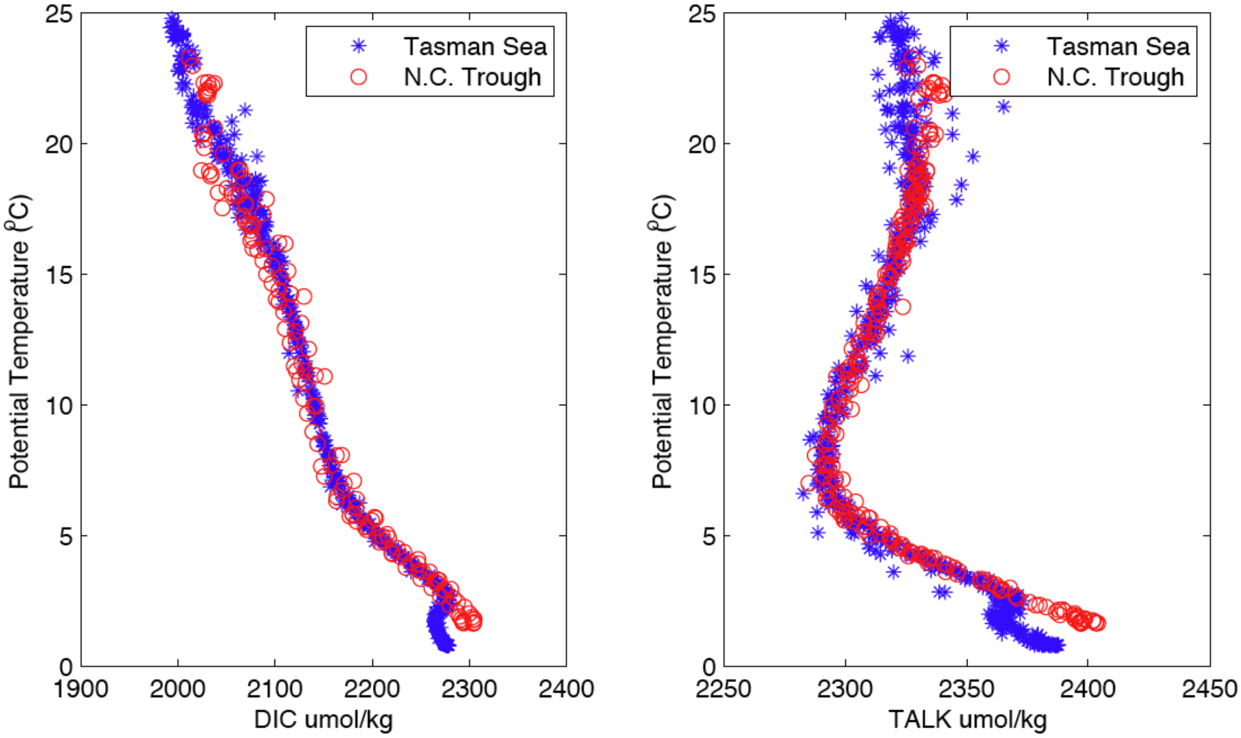

Figure E4: Comparison of 2009 Tasman Sea and New Caledonia Trough DIC and TALK values.

Before station 41, when the Wye cable had been found, Wilf Gardner's transmissometer (327DR) replaced the SIO one which we had been using. Due to unstable return, the SIO transmissometer went back on the rosette prior to station 72.

On December 3rd, while still in Norfolk Basin to the Northwest of New Zealand (between stations 47 and 48) we were forced to make a detour to Norfolk Island to med-evac one of the crew, who had developed some serious psychological symptoms. We had a few worrisome days while we waited to hear whether the problems he had been experiencing were in fact psychological (as was eventually determined) or the result of meningitis. Prior to finding out about these issues, we had been trying to determine why our casts were going so slowly. It turned out that for some of the casts, the winch speed was averaging 20 m/min. This problem was corrected, and was likely the result of inexperienced console operators, and the inexperience of at least one of winch operators (the one who later turned out to be ill). The one advantage of the side trip to Norfolk Island was that it afforded many of the groups the opportunity to get caught up on their analysis after numerous narrowly spaced stations over the steep topography.

At Sea – Week 3:

Crossing the Fiji Basin, station sampling continued smoothly and our casts were followed by albatross and petrels, which we photographed and filmed, and photographed again. Bob, our cook wrote to a friend and expert on these birds and received the following response, which we include here as it suggests a possible further, and unexpected use of repeat transects.

During this week, which included two Thursdays as we crossed the dateline, there was a flurry of activity, working on Styrofoam cups, both for ourselves and for the schools who were participating through our outreach website. Everyone wanted their cups to go down on our deepest casts at the Kermadec Trench, on the eastern side of the Fiji basin, past the Colville Ridge and Havre Trough. The cups for each of the schools were photographed next to a ruler before and after their trips to the bottom. Interestingly we noticed that the larger cups did not shrink to a consistent size even when they came from the same package of cups and were sent to the same depth on the same cast. Possibly this was due to variations in the Styrofoam, variations in the amount of paper towel placed inside the cups before they were sent down or variations in the amount of ink used on the cups. The inconsistent shrinking was particularly obvious with the Dunkin Donut's cups we sent down.

From: Ric Zarwell
To: Bob
Sent: Monday, December 14, 2009 3:54 PM
Subject: Re: **Albatross**

Hi Bob:
Thanks for sending the photos. These are just the kind of questions I enjoy working on, and you're not the only person who to send me photos to ID. So keep sending if you want to.

I would bet an awful lot on the first two photos being of one of two different species: either a **Buller's Albatross, or a Grey-headed Albatross.** The second photo is the most helpful because it shows the bill from the side. The relatively wide yellow "stripe" on the top and bottom of the bill, plus the dark coloration on the sides of the bill make me lean heavily toward Buller's Albatross. If that's not it, the bird has to be a Grey-headed Albatross - which my references show as having a narrower stripe of yellow above and below the dark sides of the bill. Albatross have juvenile plumages for several years before reaching breeding plumage, and this further complicates the ID of a bird resting on the water - but I'm going to stick with what I said above.

The third and forth photos could very well be of two Wandering Albatross, the lighter one being in adult plumage or very close to it, and the darker one still being in juvenile plumage. These two birds are considerably larger than the bird in the first two photos. Without watching these guys for several minutes in different postures, it is really a tough call between Wandering Albatross and Royal Albatross.

Do you have an ornithologist onboard who is really familiar with the different pelagic birds? If not, I volunteer!!!

Running repeated transects across the ocean and measuring physical and chemical parameters to monitor climate change is important, of course. But, at the very same time someone (like myself!) could be monitoring albatross, petrels, shearwaters, etc. for: 1) changes in how many different species are seen along the transect; 2) changes in total number of individuals for each different species; and, 3) changes in total number of all birds observed per transect, etc. Bird data like this could be gained simultaneously and then be easily compared to the other parameters that are being measured, and a good picture of how bird populations change in relation to climate change could be obtained relatively easily.

Figure E5: One of the albatross who kept us company along much of our transect (N. Williams).

All the 'extra' stations (see the introduction) were removed from our list of waypoints as we continued to struggle with keeping to the schedule. We put quite some effort into trying to determine where the time was going, but in the end, we came to the conclusion that it was simply the summing up of small delays – between bottle stops (exacerbated by the overheating of the winch, which often had to have its breaker reset when stopped on the way back up), between the various different types of casts, and the equipment issues which occasionally caused delays in sampling. These last only affected the overall time when the stations were closely spaced, which occurred fairly often to the west of the Kermadec Trench. Nevertheless, to west of the trench, we were able to maintain 30 nm station spacing limit and measured all 1992 positions.

After some noisy profiles, prior to cast 72 the original transmissometer was once again put back on the rosette on AUX 2, V2 and fluorometer was put back on AUX 1, V0. The transmissometer produced a good profile, but the fluorometer did not work. At station 73 the fluorometer cable was swapped end-to-end. It worked once plugged in the correct way.

At Sea – Week 4:

During sampling of station 77 there was the loud crash from the stern. The trace metal rosette wire had snapped and the rosette had fallen to the deck. It was fortunate, but perhaps also inevitable that it fell to the deck and not in the water, as it was thought extra strain on the line occurred as the rosette was brought up to the block. The Kevlar covered cable snapped, but the covering itself stretched. The frame was bent, but the CTD survived, and the team had the rosette back in the water in time for their next cast.

Figure E6: (left) The damage to the trace metal rosette frame caused by the snapping of the wire inside the Kevlar casing (right).

We crossed the deepest portion of the Kermadec trench on stations 78-80 where we took our deepest samples at 6000 m (limited by the rosette instrumentation). Using multibeam (EM122), which has been supplying us with some amazing bathymetric images, we measured the deepest portion of the trench at 32.5°S to be at 9226 m at approximately 178.5E.

On station 95/cast 2, we obtained extremely noisy data on all plumbed sensors on the primary side. The cast was aborted and the rosette recovered. It was quickly determined that a salp had completely plugged the T/C duct. The salp was sucked out using a syringe, the sensors were flushed with DI water and the rosette redeployed as cast 3.

Once we made it into the open basin with fairly evenly spaced deep stations, we thought we had the schedule in check. At station 96, however, the weather deteriorated after the rosette went in the water. It took 7 hours for us to get it back out of the water and the cable required retermination to bypass two kinks before the next deployment. The storm we found ourselves in the midst of brought 50+ kt winds. Exterior damage included: the loss of the air-conditioning in the HT van, which brought an end to helium sampling for leg 1, and the need to re-weld the rosette track in place, after a portion of it was ripped from the deck by a wave. In the hanger, a number of salt bottles were taken by a wave while sampling, and in the ship the main disruption was the over flowing of water baths in the lab, and wave water entering the lab through the forward bulkhead. Some glass was broken and with one computer screen.

As the storm was heading east along our track, we skipped the next station (creating the first 50 nm station spacing) in favor of the somewhat smoother ride obtained by making a dog-leg to the south. We were through the worst of the weather in 24 hours, and we forged ahead in spite of the strong swell that continued for a few more days and caused generally slow casts. The major result of the storm was that we had to lengthen the space between stations to stay on schedule. Once we were certain we could do it, we once again decreased the station spacing – this resulted in a group of stations set 40-50 nm apart, followed by stations approximately 36 nm apart. The particular station locations used included those chosen to suit the float releases, those previously chosen for tritium sampling and the one chosen at the crossing of the P16 line at 150°W.

At Sea – Week 5:

Working with the longer station spacing required by the schedule, the science teams were once again able to catch up on their analysis, so that in spite of the swell that came and went, sampling became less hurried, and everyone had time to prepare sampling bottles beforehand.

At station 102, the primary conductivity sensor reported offset readings at the bottom of cast. The offset continued on the way up with another shift occurring part way up. The primary conductivity sensor was replaced.

On station 107, the bottle spigot and boss were knocked off during recovery. The sample was lost. A bottle from the spare rosette replaced the damaged bottle. The original bottle's condition indicated a poor glue job during original construction.

On station 110, the lower cap lanyard of bottle 29 parted during deployment when a tag line snagged the lower cap. The cast proceeded without repairs. Upon recovery it was found that both the caps and spring were lost during the cast. Bottle 30 vent cap was found broken off upon recovery.

Having already spent Thanksgiving at sea, we had hoped to be able to call home on Christmas, but there appeared to be a problem with the coaxial cable in the satellite connection: we had power, but no signal. We did, however, have a wonderful 'holiday entertainment extravaganza'. This included Capt. Curl reading a heartfelt rendition of *The Grinch Who Stole Christmas*, sea shanties from science party, a variety of traditional and not so traditional holiday songs, and a documentary on the huge variety of Jack's inhabiting the ship narrated by our own version of Richard Attenborough. After a delicious supper, Santa stopped by with gifts for each of us. A good time was had by all.

At Sea – Week 6:

On station 119, the lower cap lanyard of bottle 27 was snagged during recovery. The sample was lost. The bottle was not damaged.

The Trace Metal group performed a cast at every other station: for our cruise this was on odd stations. At the request of the chief scientist, the last station for Trace Metal group was station 125. This request not to do a trace metal cast on station 127 was made in order to meet the designated time for leaving the final station required by the captain.

On station 127, the last cast of the cruise, the fluorometer reported as being blocked by foreign material during the cast. All instruments appeared fine after cast.

Following the final station, the wire was cut and the CTD/rosette was reterminated.

The end of the final week at sea, which included a three-day steam to Papeete was been used for tidying up for leg 2, and for producing the preliminary documentation. New Year's Eve celebration preparation was also in full swing. These celebrations included the evening meal prepared by the scientists, a masquerade/costume party on the stern and a non-alcoholic punch made out of whatever consumable liquids could be found, to be drunk at midnight.

Changes in T, S and O2 along the first leg of P6 (Shenfu Dong)

The P06 line was previously occupied in 1992 and 2003. The basic structure and character of the temperature, salinity, and oxygen distribution from the 2009 P6 leg 1 (Brisbane-Tahiti) measurements are consistent with those observed from previous two occupations:

(1) Both the temperature and salinity iso-contours slope upward from west to east in the upper 2000 m column, suggesting that the temperature and salinity decrease toward the east in the upper water column.

(2) One of the most distinct features is the Antarctic Intermediate Water (AAIW) which is recognized by westward extending tongues of low-salinity and high dissolved oxygen around 1000 m depth. The value of the salinity minimum decreases toward the east, whereas the value of the oxygen maximum increases from west to east. The minimum salinity is around 34.3.

(3) A lower oxygen layer between 2000-3000 m marks the Upper Circumpolar Deep Water (UCDW). The Antarctic Bottom Water (AABW) is recognized by relatively high oxygen below UCDW.

Changes in the temperature, salinity, and dissolved oxygen were found compared to the previous two occupations in 1992 and 2003. The salinity minimum at ~1000 m decreased on average by ~0.01 during the 17-year period from 1992 to 2009. Half of the observed freshening occurs during the last 6 years, i.e. from 2003 to 2009. The value of the higher dissolved oxygen above the salinity minimum layer (corresponding to AAIW) experiences an increasing trend as seen from these three occupations (Figure E7): the oxygen increased by ~5 uM/kg from 1992 to 2009. The increase in oxygen is mostly seen in the western part of the section (west of 180°E, Figure E7a).

Changes in temperature are more complex, particularly in the Tasmania Sea region where the meandering of the boundary current and eddies may be one of the main factors for the warm/cold features observed in our measurements. The abyssal ocean (below 4000 m) experienced warming trend of about 0.02°C from 1992 to 2009. The warming below 4000 m from 2003 to 2009 is about 0.01°C, corresponding to the half of the warming experienced in the last 17 years.

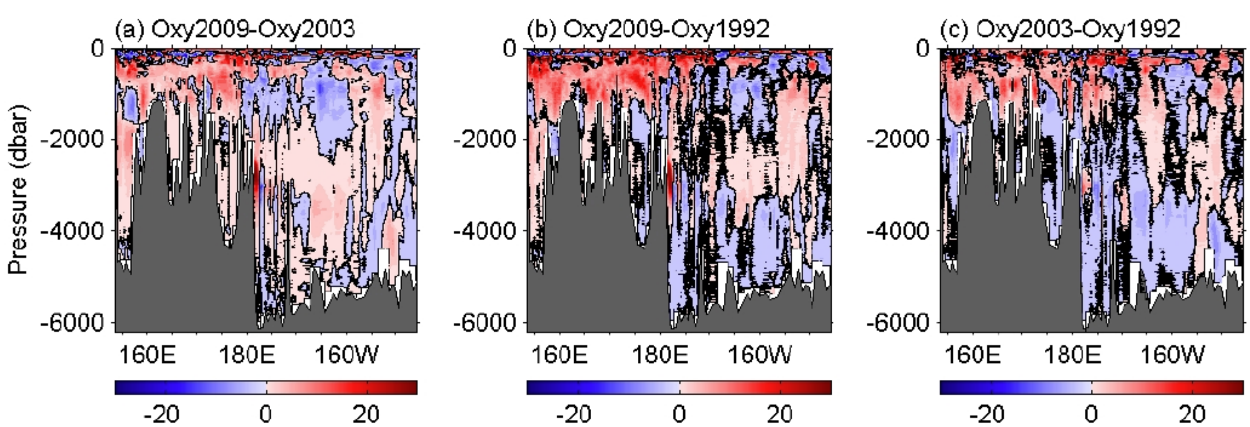

Figure E7: Oxygen Differences between (a) 2009 and 2003, (b) 2009 and 1992 and (c) between 2003 and 1992.

Results from the TM program P6
(Chris Measures)

The CLIVAR trace metal program (TM) is designed to provide data on the distribution of dissolved Fe and Al along selected tracks of the CLIVAR repeat hydrography program. Deriving a global data set of dissolved Fe data in the upper waters of the ocean is important to help constrain global climate models that seek to incorporate the effects of the abundance of this element on primary production and the global carbon dioxide cycle. Dissolved Al is important as it is a tracer of the locus and magnitude of dust deposition to the surface ocean, an important, but largely unquantified, vector for the delivery of Fe to the surface waters of the remote ocean.

Initial shipboard results from the vertical profiles obtained by the TM program show a strong elevated dissolved Al signal penetrating to 300m associated with the East Australia current. Significant, but lower values of dissolved Al are seen throughout the Tasman Sea and a subsurface tongue of elevated Al is visible between 150 and 450m as far east as 170°W. The surface water Al values along the transect can be used to calculate dust deposition of approximately 1 g m-2 yr-1 in the Australian coastal regions decreasing to ~ 0.5 g m-2 yr-1 across the Tasman Sea. Further east values in the gyre drop ~ 0.25 g m-2 yr-1 before rising to more than 0.5 g m-2 yr-1 around 155°W. A region of enhanced dust deposition was also observed at this longitude, though somewhat further north, during the CLIVAR P16S leg.

Dissolved Fe distributions also show enhancement throughout the water column in the initial coastal part of the section, but surface water values quickly diminish beyond 160°E. Fe values continue to drop in surface waters of the gyre to less than 0.2 nM by ~ 173°W. Subsurface values also drop from 1-1.5 nM concentrations in the Tasman Sea to ~ 1nM at 175°W. A sharp drop in deep water concentrations at ~ 165°W to < 0.5nM coincides with the reduction in surface water Fe.

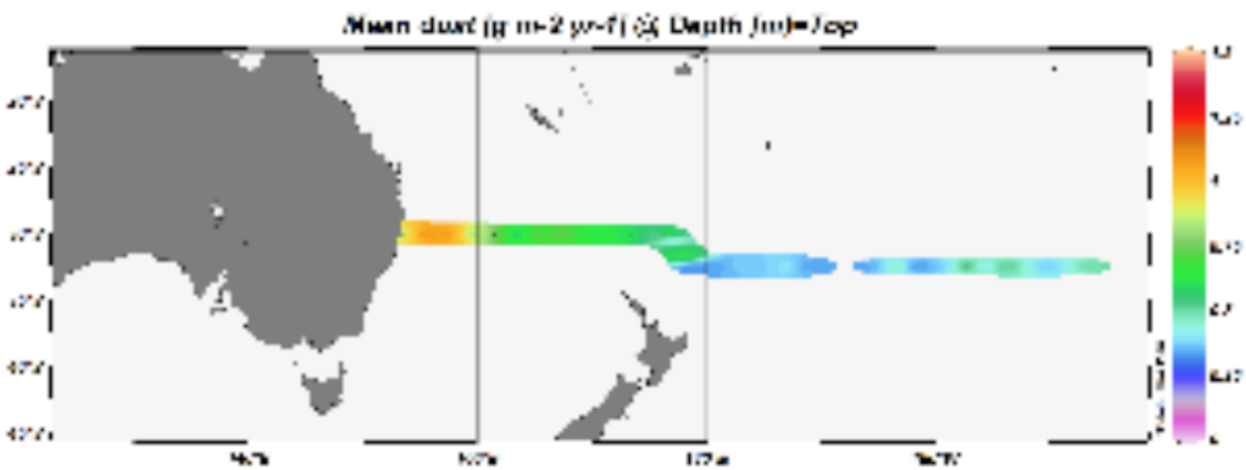

Figure E8: Column mean dust concentration along the first leg of P6.

Table E2: Sampling scheme 1 (blue in Figure E9) . We rotated through the 3 schemes, using I on station 1, II on station 2, III on station 3, I on station 4, II on station 5 etc… The column that best represented the water column above the particular bottom depth was chosen for each station. For example: for a bottom depth of 4753 m on a station using scheme I, we might choose column F, tripping the first bottle at 4745 m, the second at 4325, the third at 4100, then 3800, 3500 and so on.

P6 BOTTLE DEPTH GUIDE - SCHEME I

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
36	5	5	5	5	5	5	5	5	5	5	5	5	5	5
35	20	20	20	20	20	20	20	20	20	20	20	20	20	20
34	40	40	40	40	40	40	40	40	40	40	40	40	40	40
33	65	65	65	65	65	65	65	65	65	65	65	65	65	65
32	90	90	90	90	90	90	90	90	90	90	90	90	90	90
31	135	135	135	135	135	135	115	115	115	115	115	115	115	115
30	185	185	185	185	185	185	140	140	140	140	140	140	140	140
29	235	235	235	235	235	235	185	185	185	185	185	165	165	165
28	285	285	285	285	285	285	235	235	235	235	235	190	190	190
27	335	335	335	335	335	335	285	285	285	285	285	235	215	215
26	385	385	385	385	385	385	335	335	335	335	335	285	240	240
25	465	465	465	465	465	435	385	385	385	385	385	335	285	285
24	565	565	565	565	565	485	435	435	435	435	435	385	335	335
23	665	665	665	665	665	565	485	485	485	485	485	435	385	385
22	765	765	765	765	765	665	565	565	565	565	565	485	435	435
21	865	865	865	865	865	765	665	665	665	665	665	565	485	485
20	965	965	965	965	965	865	765	765	765	765	765	665	565	565
19	1065	1065	1065	1065	1065	965	865	865	865	865	865	765	665	665
18	1165	1165	1165	1165	1165	1065	965	965	965	965	965	865	765	765
17	1265	1265	1265	1265	1265	1165	1065	1065	1065	1065	1065	965	865	865
16	1365	1365	1365	1365	1365	1265	1165	1165	1165	1165	1165	1065	965	965
15	1535	1535	1535	1535	1465	1365	1265	1265	1265	1265	1265	1165	1065	1065
14	1735	1735	1735	1735	1565	1465	1365	1365	1365	1365	1365	1265	1165	1165
13	1935	1935	1935	1935	1735	1565	1465	1465	1465	1465	1465	1365	1265	1265
12	2165	2165	2165	2165	1935	1735	1565	1565	1565	1565	1565	1465	1365	1365
11	2415	2415	2415	2415	2165	1935	1735	1665	1665	1665	1665	1565	1465	1465
10	2665	2665	2665	2665	2415	2165	1935	1765	1765	1765	1765	1665	1565	1565
9	2915	2915	2915	2915	2665	2415	2165	1935	1935	1935	1935	1765	1665	1665
8	3200	3200	3200	3200	2915	2665	2415	2165	2165	2135	2135	1935	1765	1765
7	3565	3500	3500	3500	3200	2915	2665	2415	2415	2335	2335	2135	1935	1865
6	3965	3800	3800	3800	3500	3200	2915	2665	2665	2535	2535	2335	2135	1965
5	4365	4200	4100	4100	3800	3500	3200	2915	2915	2735	2735	2535	2335	2135
4	4765	4600	4475	4400	4100	3800	3500	3200	3165	2935	2935	2735	2535	2335
3	5165	5000	4850	4700	4400	4100	3800	3500	3415	3200	3135	2935	2735	2535
2	split spacing with bottle above													
1	8 to 10 meters above the bottom													

Table E3: Sampling scheme II (red in Figure E9) . See the explanation given in the caption of Table E2.

P6 BOTTLE DEPTH GUIDE - SCHEME II

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
36	5	5	5	5	5	5	5	5	5	5	5	5	5	5
35	25	25	25	25	25	25	25	25	25	25	25	25	25	25
34	50	50	50	50	50	50	50	50	50	50	50	50	50	50
33	75	75	75	75	75	75	75	75	75	75	75	75	75	75
32	100	100	100	100	100	100	100	100	100	100	100	100	100	100
31	150	150	150	150	150	150	125	125	125	125	125	125	125	125
30	200	200	200	200	200	200	150	150	150	150	150	150	150	150
29	250	250	250	250	250	250	200	200	200	200	200	175	175	175
28	300	300	300	300	300	300	250	250	250	250	250	200	200	200
27	350	350	350	350	350	350	300	300	300	300	300	250	225	225
26	400	400	400	400	400	400	350	350	350	350	350	300	250	250
25	500	500	500	500	500	450	400	400	400	400	400	350	300	300
24	600	600	600	600	600	500	450	450	450	450	450	400	350	350
23	700	700	700	700	700	600	500	500	500	500	500	450	400	400
22	800	800	800	800	800	700	600	600	600	600	600	500	450	450
21	900	900	900	900	900	800	700	700	700	700	700	600	500	500
20	100	100	100	100	100	900	800	800	800	800	800	700	600	600
19	110	110	110	110	110	100	900	900	900	900	900	800	700	700
18	120	120	120	120	120	110	100	100	100	100	100	900	800	800
17	130	130	130	130	130	120	110	110	110	110	110	100	900	900
16	140	140	140	140	140	130	120	120	120	120	120	110	100	100
15	160	160	160	160	150	140	130	130	130	130	130	120	110	110
14	180	180	180	180	160	150	140	140	140	140	140	130	120	120
13	200	200	200	200	180	160	150	150	150	150	150	140	130	130
12	225	225	225	225	200	180	160	160	160	160	160	150	140	140
11	250	250	250	250	225	200	180	170	170	170	170	160	150	150
10	275	275	275	275	250	225	200	180	180	180	180	170	160	160
9	300	300	300	300	275	250	225	200	200	200	200	180	170	170
8	330	330	330	330	300	275	250	225	225	220	220	200	180	180
7	360	360	360	360	330	300	275	250	250	240	240	220	200	190
6	400	390	390	390	360	330	300	275	275	260	260	240	220	200
5	440	430	420	420	390	360	330	300	300	280	280	260	240	220
4	480	470	450	450	420	390	360	330	325	300	300	280	260	240
3	520	510	490	480	450	420	390	360	350	330	320	300	280	260
2	split spacing with bottle above													
1	8 to 10 meters above the bottom													

Table E4: Sampling scheme III (green in Figure E9) . See the explanation given in the caption of Table E2.

P6 BOTTLE DEPTH GUIDE - SCHEME III

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
36	5	5	5	5	5	5	5	5	5	5	5	5	5	5
35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
34	60	60	60	60	60	60	60	60	60	60	60	60	60	60
33	85	85	85	85	85	85	85	85	85	85	85	85	85	85
32	115	115	115	115	115	115	110	110	110	110	110	110	110	110
31	165	165	165	165	165	165	135	135	135	135	135	135	135	135
30	215	215	215	215	215	215	165	165	165	165	165	160	160	160
29	265	265	265	265	265	265	215	215	215	215	215	185	185	185
28	315	315	315	315	315	315	265	265	265	265	265	215	210	210
27	365	365	365	365	365	365	315	315	315	315	315	265	235	235
26	435	435	435	435	435	415	365	365	365	365	365	315	265	265
25	535	535	535	535	535	465	415	415	415	415	415	365	315	315
24	635	635	635	635	635	535	465	465	465	465	465	415	365	365
23	735	735	735	735	735	635	535	535	535	535	535	465	415	415
22	835	835	835	835	835	735	635	635	635	635	635	535	465	465
21	935	935	935	935	935	835	735	735	735	735	735	635	535	535
20	103	103	103	103	103	935	835	835	835	835	835	735	635	635
19	113	113	113	113	113	103	935	935	935	935	935	835	735	735
18	123	123	123	123	123	113	103	103	103	103	103	935	835	835
17	133	133	133	133	133	123	113	113	113	113	113	103	935	935
16	146	146	146	146	143	133	123	123	123	123	123	113	103	103
15	166	166	166	166	153	143	133	133	133	133	133	123	113	113
14	186	186	186	186	166	153	143	143	143	143	143	133	123	123
13	208	208	208	208	186	166	153	153	153	153	153	143	133	133
12	233	233	233	233	208	186	166	163	163	163	163	153	143	143
11	258	258	258	258	233	208	186	173	173	173	173	163	153	153
10	283	283	283	283	258	233	208	186	186	186	186	173	163	163
9	310	310	310	310	283	258	233	208	208	206	206	186	173	173
8	340	340	340	340	310	283	258	233	233	226	226	206	186	183
7	373	370	370	370	340	310	283	258	258	246	246	226	206	193
6	413	403	400	400	370	340	310	283	283	266	266	246	226	206
5	453	443	430	430	400	370	340	310	308	286	286	266	246	226
4	493	483	463	460	430	400	370	340	333	310	306	286	266	246
3	533	523	503	490	460	430	400	370	358	340	326	306	286	266
2	split spacing with bottle above													
1	8 to 10 meters above the bottom													

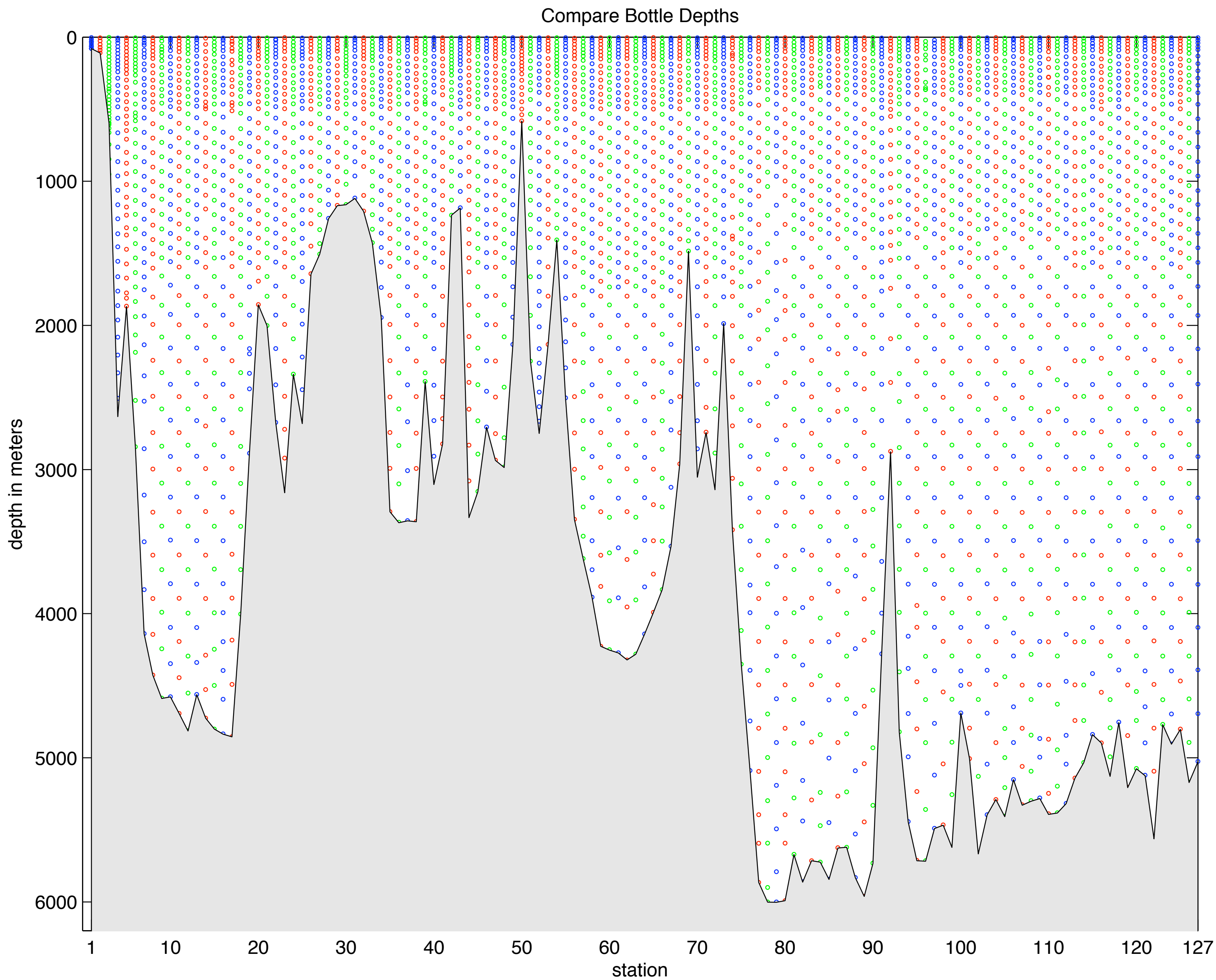

Figure E9: Shows the effect of the sampling schemes. Schema I, II and III in blue, red and green respectively.

Outreach web: http://www.whoi.edu/cruise/clivar-p6

We began a web site for this cruise as a way to talk to one classroom, but ended up directly contacting seven. Woods Hole Oceanographic Institution help by housing and maintaining the website. Our thanks to Dina Pandya and Annie Doucette for their onshore help in getting it organized and keeping it up to date. Frank Delahoyde made it possible for us to send large images and video back to shore so they could be included. All the student watch standers, especially Karen Stamieszkin, as well as a number of others in the science party, contributed text and images, and a number of the crew also contributed photos and movies to the web site. The overall effort involved was enormous. We could have easily used somebody working full time just on the website. Please visit it. We will try to include the missing pieces once we return to land.

CLIVAR P6 Students:

Our students were exemplarily, working as CTD console operators, sample cops, salt and nutrient samplers, deck hands, gophers, artisans, knot tiers extraordinaire, and the main contributors to the outreach website. They were an enormous help to everyone throughout the cruise as they learned to sample pH, alkalinity, tritium and eventually DIC, as well as learning to run the salt analysis. They did all of this with a smile, and never failed to jump enthusiastically to any task asked of them.

A special thanks to Carolina Berys for handling LADCP operations during the night shift and to Karen Stamieszkin who worked long hours to provide exciting pictures, vivid interviews, and journal entries with her own touch of “sarcasm” for our outreach website. Mimi Szeto put together notes for everyone on how to run the console, and she and Carolina also put together the *Watch Note* entries for the website, while Liz Burakowski contributed by answering email questions. As a final note: Liz, Karen and Shenfu hold the record for fastest cocking of 36 bottles at 3 minutes and 13 seconds, including valve tightening, syringes and window cleaning (tops and bottoms not cocked simultaneously). The other team was overwhelmed by the overpowering need to triple check all components of the setup, and so found themselves unable to compete at this level.

We had two other students with us. One was Il Nam Kim, funded through the NSF CLIVAR grant he worked with the University of Miami/RSMAS CFC group. While at sea he became at expert cribbage player, while waiting for the various pings and whistles of the CFC analysis system. When not on shift he spent his time developing a theory on the circulation of old and new Antarctic waters that he presented at our final science meeting, Jack Payette was hired on literally at the last minute when one of the trace metal group became ill. Jack has been a wonderful addition to both the TM group as well as to the cruise as whole. He too contributed to the web page effort writing articles and providing pictures and movies.

Our thanks to you all. We couldn't have asked for a better team of students.

Here we present some of their stories. Others can be found on the outreach web site at http://www.whoi.edu/cruise/clivar-p6.

Liz Burakowski

I am a first-year PhD student at the University of New Hampshire. My dissertation research focuses primarily on aspects of winter climate change in relation to changes in surface albedo. I plan to use climate modeling to capture the influence of synoptic scale climatological oscillations such as the El Nino Southern Oscillation, the Pacific Decadal Oscillation, and the North Atlantic Oscillation. I decided to participate in the 2009-2010 CLIVAR P6 cruise to gain hands-on data collection experience during an El Nino winter.

As a watch stander, my primary responsibilities have been to assist in the deployment and recovery of the 36-bottle CTD carousel and the trace metals carousel, to collect nutrient and salinity samples, and to ensure that all other water samples are properly collected and accounted for. Through speaking with the other research teams, I have learned a lot about the relationships between climate and the carbon cycle. In particular, I was most intrigued by the research conducted by the Dissolved Organic Matter (DOM), Chlorofluorocarbon (CFCs) and Trace Metals (TM) teams. I look forward to reading the peer-reviewed publications that will be made possible by the data collected on this cruise.

My previous experience at sea had been with the Sea Education Association (SEA) based out of Woods Hole, Massachusetts. As an SEA scientist, I had mentored high school and undergraduate students through oceanographic research projects in biological, geological, chemical and physical oceanography. It has been a great experience to compare the research methodologies of SEA with the large-scale operation of CLIVAR.

Overall, I was surprised at how well SEA prepared me for the rigorous collection of high quality oceanographic datasets. While I sometimes longed for the peaceful quiet of sailing under wind power, it was quite a treat to spend time at sea with the luxuries of internet, laundry, and of course the hot tub under a full moon on the upper deck of the R/V Melville. The crew of the R/V Melville have been fantastic, and I hope to see them again on future cruises.

Mimi Szeto

Hi. My name is Mimi Szeto. I am a graduate student at the University of New Hampshire (UNH) . I study marine bio-optics, which is part of the basis for developing satellite imagery of oceanic properties. As CTD student watch stander for CLIVAR P6, I have been part of the team that handles the logistics of collecting water at different depths and distributing it to the various technicians who process the samples.

This experience has been a tremendous blessing, as I had never had much experience at sea even though I had just finished writing my Master's Thesis using a dataset of in situ measurements made on cruises comparable to P6. With exposure to this other side of oceanography, I am certain that I am leaving with a more realistic and comprehensive perspective on data analysis and modern oceanographic science in general.

Initially, I was inundated with unfamiliar terminology and disappointed by my clumsiness when trying to prepare the rosette for deployment. My eagerness to understand all the required tasks at once led me to focus too much on each nitty-gritty detail. Sending Rosie (my nickname for the rosette) down to deep waters and returning it safely with the desired water samples is not a trivial matter! We're handling a 200, 000-dollar rosette in water 5000 m below the surface!

With more casts, I learned to calm down, and my 2 AM -2 PM shift soon seemed more familiar, and consequently, more tedious. Charlene, one of the technicians for CFCs, helped me see the significance of the repetition to the overall goal, and this helped me maintain a positive attitude. Every so often, I also reverted to the initial rush of excitement -- which I'd say lasted for a good week-- upon touching the exotic water from 4000 m deep.

Aside from accomplishing my duties as a watch stander, the most important aspect of this journey has been the dialogue I have accumulated with everyone onboard. With these conversations, I have learned much on the subject of collecting oceanographic data, particularly about the different roles required, from my bottom-rung-of-the-ladder position to that of the project investigator, and the international committee in charge of the funding. In addition, I see my textbook-based perspective on oceanography evolving to one that incorporates the organic aspects we never learn about in school. I can now better conceive some of the innumerable sources of uncertainty, and also appreciate the immense effort put into organizing the entire project. I know this change in perspective will only add to the rigor of my future endeavors in oceanography.

Karen Stamieszkin

My interest in the CLIVAR P6 cruise began with a desire for more experience at sea. Previously I had participated in numerous single day biological research cruises; I had never been at sea for an extended period of time, nor had any substantial experience with physical oceanography. My background is a mosaic of work relating to ecology and natural resource management, with an emphasis on marine science. I am currently an associate scientist for the Right Whale Habitat Studies program at the Provincetown Center for Coastal Studies, though I plan to return to school to begin a PhD within the next two years. It was therefore also my hope that the P6 cruise would expose me to various fields of oceanographic research.

As a CTD watch stander on the P6 cruise, I learned the ins and outs of collecting water for analysis. I also had the opportunity to discuss the research of the many groups onboard with scientists and technicians. Exposure to these projects is important to me, as I aim to have a holistic vision of climate research, and how it gives us a complete understanding of oceanographic processes in relation to climate change. In addition to the scientific aspects of the P6 cruise, I enjoyed learning about the operation of the R/V Melville; with an understanding of the technical aspects of oceanographic research I have a greater appreciate for the breadth of resources and expertise necessary to conduct successful oceanographic research.

Carolina Berys

As a data manager at Scripps Institution of Oceanography, participating in a CLIVAR cruise and experiencing the data collection process first hand has been an incredibly enriching process both professionally and personally.

My duties on board allowed me to take part in data collection, along with observing the other scientists and technicians to better understand the importance and nature of meta-data. As a CTD watch stander, my duties included deck work (deploying and recovering the rosette), acting as sample cop (coordinating and documenting sample 'traffic'), console watch (executing bottle trips to grab water samples as the rosette rose from the sea bottom), and taking samples (primary samples nutrients and salinity, and also assisting other scientists sampling pH and DIC), and training in running the salt analysis on the salinometer. An auxiliary part my job was contributing to outreach materials (www.whoi. edu/cruise/clivarp6,www.ushydro.ucsd.edu/outreach). Additionally, I assisted as the night shift LADCP data collector, which consisted of connecting and downloading data from the equipment after coming on deck.

Working alongside experts with decades of experience in the field has given me an even deeper sense of appreciation for conscientious process execution in the face of numbing repetition, 34 careful record keeping, and how valuable the keen eye of a dedicated professional is. The myriad of technical difficulties and factors that go into each cast and the work of the talented scientists I had the pleasure to work along side with reminds me of the need for documentation and meta-data to ensure that the meticulous work being done remains useful and viable for future scientists and research purposes.

Aside from learning a great deal about hydrography, I learned a great deal about myself as well the great beauty that abounds in the vast oceans that cover this planet of ours. I gained friendships, shared experiences, and memories with my fellow cast members that I will treasure dearly.

Il Nam Kim

First of all, I'm so glad to participate in the P6 cruise. Even though this is the longest cruise of my experiences, I could learn many things to be a real oceanographer. I worked at SF6/CFCs team as student analyst. I have seen the peak of CFCs at the bottom only through book and paper, indicating deep water formation. Fortunately, I could get water samples by my hand and see directly the peak by eye, showing new Antarctic Bottom. It was a wonderful experience in my oceanography life. Also, I was truly happy to work with Charlene and Jim.

Jack Payette

My name is Jack Payette, I am a recent graduate of The University of New Hampshire with a bachelor's degree in Oceanography. I first heard about the CLIVAR P6 cruise from my oceanography professors I had at UNH as an undergrad who forwarded me the email from Alison Macdonald the Chief Scientist. I applied for the CTD watch stander positions, but didn't get one, due to the high volume of applicants, and preference for graduate students (I hadn't yet gotten into a graduate program). However, only 2 weeks before the cruise started, I got an email from Professor Chris Measures a P. I. from the University of Hawaii saying that he needed someone to work with his trace metal group aboard the cruise. I emailed him back right away, the very next hour, and told him a definite YES!

I had participated in a NOAA hydrography cruise as a mapping intern/watch stander for about 15 days during September 2009, this was when I first received the email about P6. Leg 1 of the CLIVAR P6 cruise was 44 days, nearly 3 times longer than my first cruise with NOAA. I was glad I had done an oceanography cruise before, so I knew what I was getting into. The fact that the R/V Melville is a Scripps Institution of Oceanography, UNOLS vessel was a big plus for me. In fact, the Friday before I flew out to Brisbane I submitted my graduate school application to Scripps for a PhD in Oceanography. This has been my first long, serious oceanographic research cruise, and it has been a great experience. I have had a wonderful time, learned a lot, and I would certainly do it again. I have truly enjoyed being part of the trace metal chemistry group. Even though I spent many long hours doing tedious trace metal clean sub-sampling in the back of our Van, this has been a worthwhile experience. I have learned a lot from Chris, as well as Bill his post-doc, and Max his graduate student. I got an inside look at what trace metal chemical oceanographers do. It was great working with the trace metal group because some of my research interests do overlap with them. Also seeing, and learning from everyone one aboard has helped me personally, gain a better understanding of what I want to do. It's been great just talking to other people, whether they are researchers, students, scientists, technicians, post-docs, or something in between like me. I have truly benefited from everyone's unique perspective, and the variety of research that has been done on P6. My only wish is that we had a few more biologists on board! It's been a great cruise overall though, and I have made many great connections. I can only hope to do a similar cruise again, and maybe see or work with P6ers in the future.

Conclusions and other items:

One of the major successes of this cruise has been the shipboard website which was able to supply current station data to everyone aboard almost immediately upon recovery. Obviously, water sample data came a little later, but the various groups were usually able to supply their numbers within a day of sampling. Our data analysts and computer tech have been invaluable in this capacity, as well as, in all their handling of data calibrations and issues. Our thanks to the SIO/ODF/Data/Computer Tech Team.

From the very start the science team felt welcome and very well supported onboard the R/V Melville. This was the fifth cruise for the CLIVAR/CO_2 Repeat Hydrography Program on an SIO ship. We have enjoyed the good fortune of sailing with highly experienced officers and crew, many of whom had sailed on previous cruises for the CLIVAR program. All our initial concerns about fitting so many different science groups onto Melville have proved completely without basis. All the crew, from the captain on down helped make this happen. Built in 1969, the ship has been well-maintained and well outfitted for long cruises such as P06.

The captain, Chris Curl has been a constant source of support and good humor, and as he says himself 'perhaps too approachable,' It was he who pushed for the weekly science meetings, which have been a great success and which he has attempted to attend, even though sampling has made them moveable affairs. He and Eric, the 1st mate, have also dealt sensitively and professionally with three medical situations. Our winch operators, Joe, Bob, Matt, Will and Pete kept our tension down and brought the rosette back every time, setting it neatly at our feet, and letting us feel like we had done ourselves. Our extremely talented chefs, Bob and Richard, have fed us all manner of delicacies, and along with making bread every day for dinner, they have been singularly responsible for bringing the night crew back to life in the mornings with a resuscitation method based on hot scones and muffins with Starbucks coffee at 06:00. They also have managed to always include something for the four vegetarians on board, along something resembling salad, even today on our 41st day at sea. Of course, at lunch today, the white board displaying the dinner menu stated "Out of Food". This state of affairs should make the New Year's Eve dinner the scientists are preparing tomorrow an interesting meal. But seriously, all the crew has been not only supportive of our science needs, but also genuinely interested in what we are doing. They have joined us at meals, between meals, in the cribbage tournament (Dave Grimes, the boatswain, created a beautiful wooden cribbage board as a trophy) and in our holiday celebrations. It has been a pleasure sailing with them.

Given all properties measured, and number and variety of casts, the chief and co-chief scientists would like to commend the ship's crew, all the various science groups, and particularly, our multi-talented SIO deck managers/restechs, Rob and Keith for their hard work, contentious effort, and willingness to work cooperatively, and with good humor. This effort has allowed us to overcome technical, meteorological, and medical difficulties and bring this first leg to a successful conclusion.

Data Processing Notes

<table>
<tr><th>Date</th><th>Person</th><th>Date Type</th><th>Event</th><th>Summary</th></tr>
<tr><td>2009-11-18</td><td>Diggs</td><td>Metadata</td><td>Website Update</td><td>Cruise track/Prelim doc online</td></tr>
<tr><td></td><td colspan="4">Cruise map, metadata and PDF planning documents online</td></tr>
<tr><td>2010-02-08</td><td>Johnson</td><td>BTL</td><td>Submitted</td><td>CTDO/TraceMtls to go online</td></tr>
<tr><td></td><td colspan="4">Action: Place Online
Notes: Preliminary Bottle, CTDO and Trace Metal Data for P06 Leg 1</td></tr>
<tr><td>2010-02-09</td><td>Schatzma</td><td>BTL/SUM</td><td>Submitted</td><td>Updated files</td></tr>
<tr><td></td><td colspan="4">Action: Place Online
Notes: Please replace data Mary sent Fri with these 3 files.</td></tr>
<tr><td>2010-02-09</td><td>Diggs</td><td>BTL/CTD/DOCS</td><td>Submitted</td><td>corrected data, docs from ODF</td></tr>
<tr><td></td><td colspan="4">Preliminary CTD and Bottle data are available in the following formats:
• WHP-Exchange format (_hy1.csv/_ct1.csv)
• WHP90.1 format (*.sum/*.sea/*.ctd)
• WHP NetCDF format (CTD only, *.nc).

Preliminary documentation from all leg 1 groups is also available. SBE Calibration coefficients and shipboard corrections were applied to all STS/ODF CTDO data in this release. Only minor changes, if any, are expected to be made to this data set.

Only the most basic processing (block-averaging) was performed on the Trace Metal CTD data. 2007-2008 SBE calibration data (same as used for CLIVAR I05) were provided by U. of Hawaii and applied to Pressure, Temperature and Conductivity (Salinity). Preliminary oxygen corrections from CLIVAR I05 (which used the same SBE Oxygen sensor) were applied to TM Oxygen data in order to get them in the ballpark. No corrections were applied to Fluorometer data. TM data were ONLY collected during Leg 1.</td></tr>
<tr><td>2010-02-16</td><td>Kappa</td><td>Cruise Report</td><td>Website Update</td><td>Various reports Merged, online</td></tr>
<tr><td>2010-03-04</td><td>Diggs</td><td>BTL/CTD/SUM</td><td>Website Update</td><td>WHP/NetCDF/Exchange files online</td></tr>
<tr><td></td><td colspan="4">Bottle WHP format and Exchange, CTD Exchange and CTD-NetCDF now online. NetCDF CTD do not contain TRANSM,FLUORM, or CTDETIME as they are "products". Bottle Exchange is online, however, new parameters will either need to be handled properly or excluded in NetCDF files for these discreet data.</td></tr>
<tr><td>2010-03-31</td><td>Bartolocci</td><td>BTL</td><td>Website update</td><td>Updated file online</td></tr>
<tr><td></td><td colspan="4">2010.03.8 DBK
Reformatting the updated P06_318M20091112 bottle file:
Original file was p06_318M20091112_orig_hy1.csv
Exchange file:
• edited PH_TEMP to PH_TMP
• edited REF_TEMP to REF_TMP
• edited CHLOR to CHLORA
• edited CDOMSLOG to CDOMSL
• removed PHOTOLYSIS as per Norm Nelson. These values may come in at a later date, but it is unclear at present.

NOTE: It should be noted that the parameter mnemonic BACT currently denotes heterotrophic bacterioplankton at CCHDO, however the data expected for that column is of cyanobacteria and may therefore be changed once data are submitted.

Edited file named: p06_318M20091112_orig_edt_hy1.csv</td></tr>
</table>

- Ran copy_bottle_data.rb to re-order parameters in the exchange file and as a bit of a first pass format check. Ordered file named: p06_318M20091112_hy1.csv. This file was then copied to p06_318M20091112_hy1.csv
- NOTE: Because the exchange to netcdf code was crashing based upon placement of the BOT_LAT, BOT_LON parameters, these two parameters were moved in the file to follow other bottle parameters in order.
- Ran exbot_to_netcdf.pl to convert exchange bottle file to netcdf files. Zipped the resultant files into file: p06_318M20091112_nc_hyd.zip. ncdump of random stations indicates the conversion ran with no errors.
- Ran exchange_to_wocebot.rb to create a woce formatted bottle file, however attempts to format check file are not possible due to the large number of non-woce parameters within it. File was visually checked and put online.